POWER

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The Engineering Student and the Job

A COMMUNICATION from Prof. Wm. T. Magruder on another page sets forth the inability of his university to furnish graduates for all the situations that are offered and deplores the fact that more boys do not turn to engineering as a profession.

There is in it a note of deprecation for the man who decries and belittles technical training and has no use for what he calls "kid-glove engineers."

That many industrial leaders do appreciate the advantages of a technical education and know how to use to advantage boys who have obtained it, is evident by the demand for such graduates of which Professor Magruder writes.

That some managers do not get what they go after when they take young men from engineering schools may be because they are poor pickers or because they have a mistaken idea of the product.

Some industrialists seem to think that the function of a mechanical school is to turn out a superior sort of craftsman, and are provoked because a boy who comes from four years of contact with books and mental processes cannot, on sight, grapple with and throw the physical and mechanical problems of their particular industries.

And yet these same employers have been provoked more often at the inability of those upon whom they are dependent to use their heads.

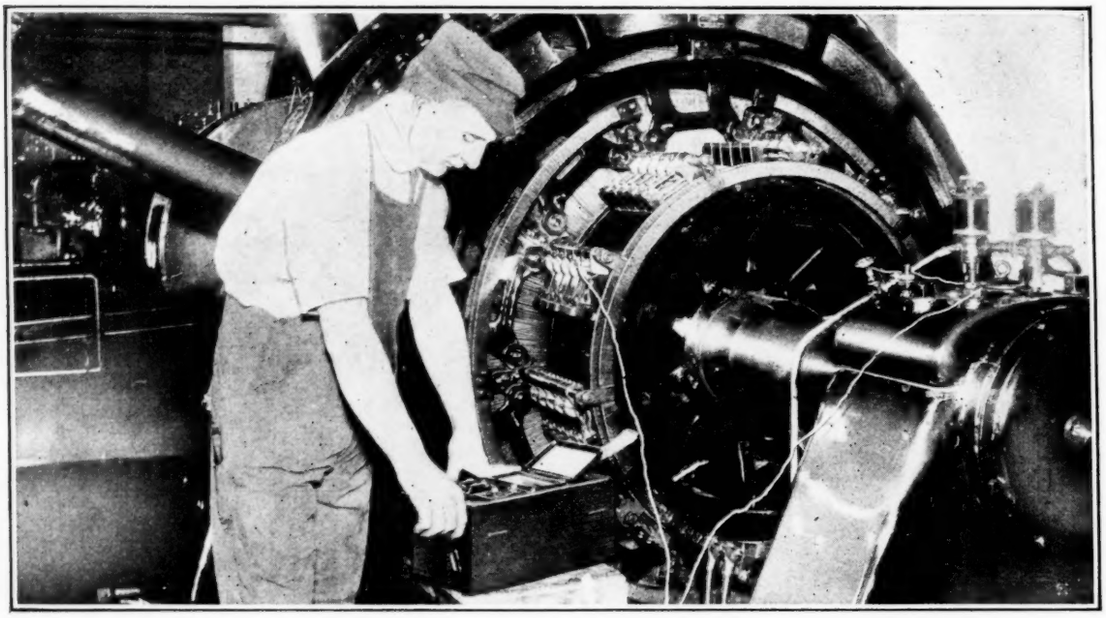
That is what a college or technical school is for— to teach boys to think, to use their brains, and to give them the fundamental principles of the profession and the mental tools to use in applying them.

It is this ability to think and reason; it is the trained and activated brain rather than the skillful hand, that those industrialists seek who know what they are after when they go to the graduating class of a technical school. And they usually get it. But education does not always "take." There is no effectual textbook on Gumption.

The boy with no especial interest in or aptitude for it, who struggles into a profession because he thinks it will yield him a good living, may get a diploma but will never shine unless lighted up by a real awakening to its inherent interest.

The fond parent who shoves his boy through a mechanical school because he is handy in the use of tools, is likely to spoil a first-class mechanic to add mediocrity to the ranks of the engineering profession.

F. R. Low



Testing the insulation resistance of a large direct-current generator

What do You Know

About the Insulation of Your Electrical Machines?

By Clair L. Keene

Field Engineer, Columbia Casualty Company, New York City

SERVICE continuity of electrical equipment is closely associated with the conditions of its insulation. This fact is being more generally appreciated, and increasing attention is given to this part of the apparatus as a means of detecting faults and correcting them before they develop into a complete failure. In this article the author shows how dirt, moisture, temperature and voltage affect the quality of insulation and tells how tests are made to determine the condition of electrical-machine insulation.

WHAT is meant by the term insulation resistance? Dielectric strength and insulation resistance are frequently confused in their meaning. Insulation resistance has been defined as "The actual resistance as measured with direct current between conducting parts which are insulated from each other." The A.I.E.E. definition is: "The insulation resistance of an insulated conductor is the electrical resistance offered by its insulation to an impressed voltage tending to produce a leakage of current through same." Dielectric strength is that property possessed by a material whereby it is able to resist disruption of its molecular structure when subjected to a difference of potential. Insulation resistance is measured in megohms (1,000,000 ohms), while dielectric strength is measured in volts.

If an alternating potential difference is applied to two conductors separated by a dielectric, two different currents flow through the dielectric. One is the so-called "displacement," or condenser current, and is apparently the result of some kind of molecular displacement. The other is the "leakage," or conduction current, which depends upon the resistance of the dielectric. If the voltage between the conductors is increased sufficiently, a breakdown of the dielectric occurs and a current flows which is limited only by the impedance of the circuit. Fig. 1 illustrates this variation of insulation resistance of a cotton-insulating material with applied voltage as obtained by Monkhouse. This curve is typical of absorbent insulating materials. It will be noted that the first part of the curve down to the point *A* drops rapidly. This is caused or determined by the moisture content of the material, and consequently the leakage current. The second part of the curve down to the point *B* drops more slowly, the resistance remaining fairly constant.

The shape of this part of the curve is dependent upon the nature and condition of the insulation. When 200 volts was applied across the insulation, the resistance was 100 megohms. With 800 volts applied, the insulation resistance decreased to 60 megohms, which shows a gradual weakening of the insulation as the voltage is

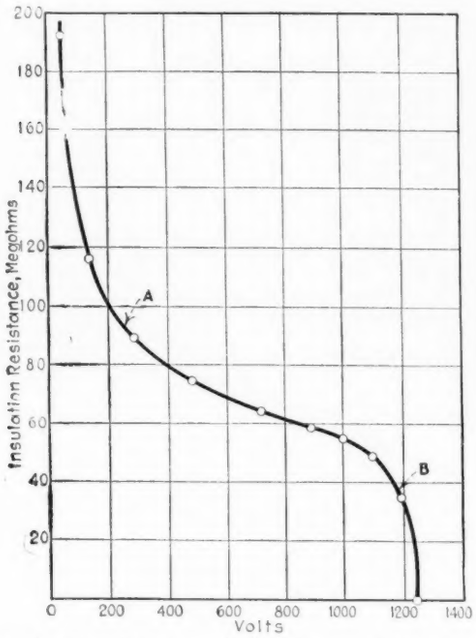


Fig. 1—Curve shows variation in insulation resistance with change in voltage

increased. When 1,200 volts was applied or shortly after, disruption of the insulation occurred.

Many factors affect insulation resistance, and the more important ones will be noted briefly in the following paragraphs.

The resistance of an insulating material decreases as the temperature to which it is subjected increases. The influence of temperature on fibrous insulation containing no moisture, as obtained by Flight, is shown in Fig. 2.

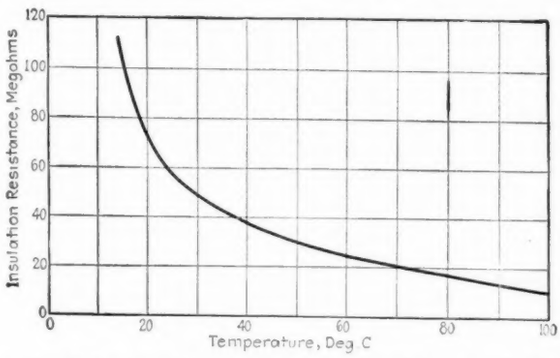


Fig. 2—Effects of temperature on resistance of fibrous insulation

If the temperature is increased to a point beyond that shown in the figure, carbonization begins and the dielectric will then act as a high-resistance conductor. From this it is evident that temperature is an important factor in the life of insulation of electrical machines.

Nearly all insulating materials have the property of absorbing moisture, and the humidity of the air has a marked influence on their insulating properties. As their moisture content is increased, their insulating qualities decrease. Moisture increases leakage current. Fig. 3 shows the typical variation of insulation resistance containing moisture, such as that found on new or rewound electrical machines, when subjected to a drying-out process. It will be noticed that the insulation resistance falls rapidly as the temperature is increased, until all

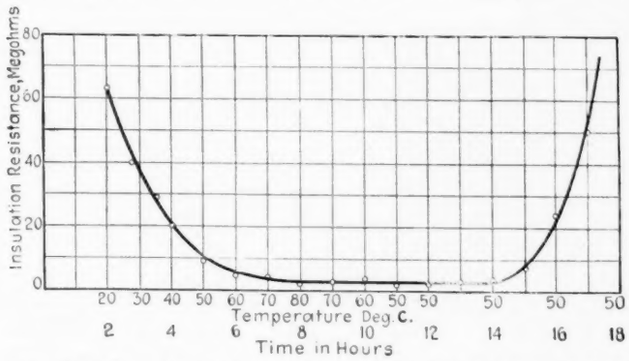


Fig. 3—How insulation resistance of a 25,000-kva. 9,000-volt generator varied while being dried out

the moisture has been driven off; then it increases again. When this occurs, the apparatus is in a fit condition to go into service.

The time required to dry out a piece of equipment, depends upon the moisture content, the range of temperatures during the drying out, size of machine and the rapidity with which the heat is conducted away. This

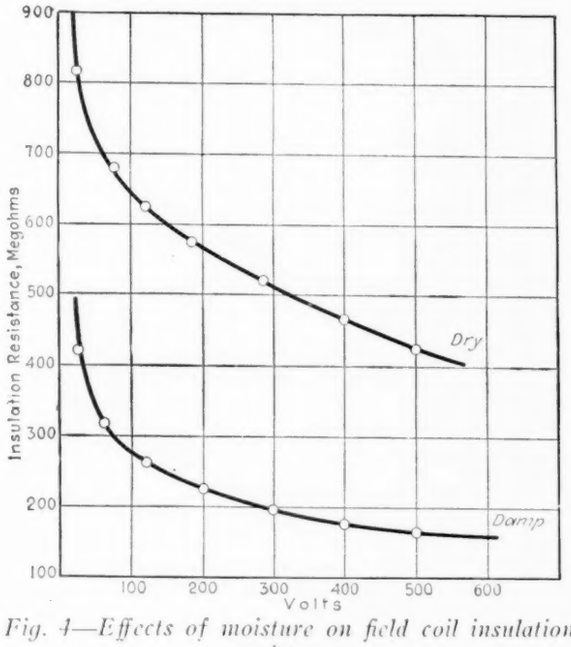


Fig. 4—Effects of moisture on field coil insulation resistance

may take from several hours to several days. Fig. 4 gives the results obtained by Evershed on testing field coils on a dry day and then on a damp day. It is important, then, to keep electrical machine insulation as dry as possible. Periodic drying and revarnishing the insulation will greatly increase the insulating properties and the life of the machine.

Dirt deposits on insulation are a frequent source of trouble. They increase surface leakage and sometimes, if accompanied by lubricating oil, cause leakage from the

conductor to the surface of the insulation. The effect of cleaning the various insulating parts can be determined by checking the insulation resistance after each part has been attended to. It is essential to good service that the insulating parts be kept clean. Fig. 5 gives the seasonal variation of the insulation resistance of a number of 80- to 120-hp. 230-volt direct-current motors at a large power plant, all motors being operated under practically the same conditions. The variation is, of course, due to the combined effects of moisture, temperature and cleanliness. It will be noted, however, that there is a decided drop in the insulation resistance of all the motors during the summer months, due, undoubtedly, to atmospheric conditions and temperature.

From this it is evident that the measurement of insulation resistance indicates that certain conditions exist which will allow leakage or conduction current to flow, but it does not give any knowledge of its dielectric strength. It affords no indication of the quality of the insulation employed. But insulation resistance measurements are valuable in determining the condition of the insulation as to dryness and cleanliness. Prolonged drying will increase the resistance of any of the common insulating materials to a considerable extent, provided the temperature is kept within the safe limits. These measurements are of most value when they are compared with previous values on the same machine. By periodically measuring the insulation resistance, any sudden

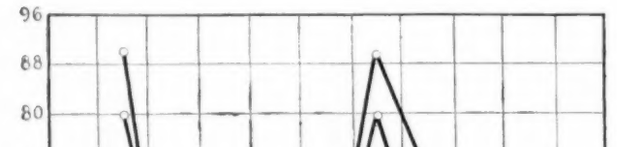


Fig. 5—Seasonal variations of insulation resistance of direct-current blower motors

or gradual depreciation of the insulation can be detected before breakdown results. When machines are dried out before going into service, they give a clear indication of the extent of the drying. The A.I.E.E. Standards give the following:

"The insulation resistance of machinery is of doubtful significance as compared with the dielectric strength. It is subject to wide variation with temperature, humidity and cleanliness of the parts. When insulation resistance falls below prescribed values, it can, in most cases of good design, be brought up to the required standard by cleaning and drying the machine. The insulation resistance, therefore, may afford a useful indication of the dielectric test, but should not be considered a requirement of these standards."

The question may be asked: What is an acceptable value of insulation resistance for some particular apparatus? No hard and fast rule can be laid down as safe for machines under any particular conditions. It must be borne in mind that it is the variation of the insulation

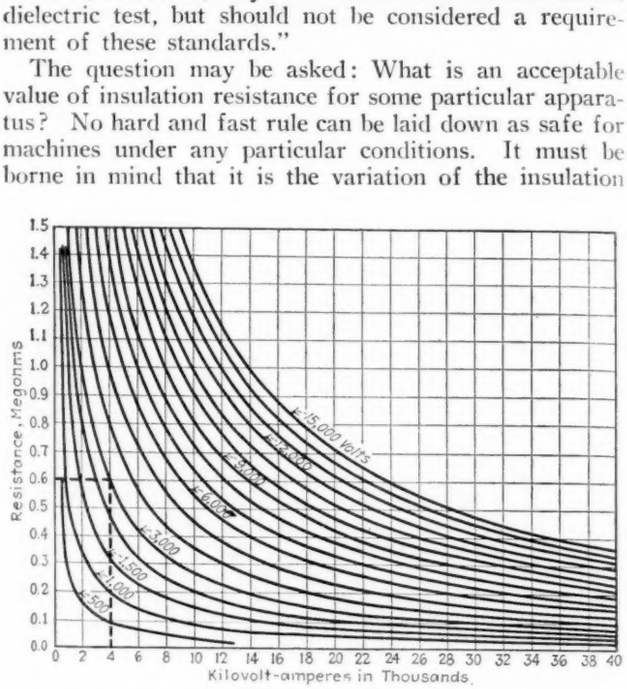


Fig. 6—Curves giving allowable minimum values of insulation resistance, based on A.I.E.E. standards

resistance itself. The A.I.E.E. recommend that the insulation resistance of any machine should not fall below the resistance given by the formula,

$$\textit{Insulation resistance in megohms} = \frac{\textit{Voltage at terminals}}{\textit{Rating in kva.} + 1{,}000}$$

The curves in Fig. 6 are plotted with capacity and voltage variable so as to give values of insulation resistance according to this formula. For example, a 4,000-kva. 3,000-volt machine should have an insulation of about 0.6 megohm, or 600,000 ohms, as indicated by the dotted line.

Insulation resistance tests are usually made upon completed apparatus by the manufacturer. Sometimes buyers specify the minimum values of insulation resistance acceptable. Periodic tests are made by many railroads, public utilities and some of the larger industrial companies on their electrical equipment. The larger insurance companies make these tests on their insured equipment, and a considerable number of undesirable conditions are detected, many of which would eventually result in breakdowns.

It has been recommended by the A.I.E.E. that an insulation resistance test be made on a machine before the application of a high-potential test to determine if the machine is in a fit condition for the application of high voltage, and then after the test to determine if any of the insulation has been weakened by the test. As mentioned before, it is extremely important that the conditions under which the insulation resistance is measured be noted, so as to be able to compare this value with previous or subsequent tests.

These tests are sometimes made by the so-called voltmeter method. By this method a high-resistance voltmeter is connected as shown in Fig. 7. The insulation resistance $R = \frac{r\,(E-e)}{e}$, where r equals the resistance of the voltmeter, in this case 30,000 ohms; E equals the

line volts, 230, and e equals the voltmeter reading, assumed to be 5 in the figure. Then, in this case the insulation resistance $R = \frac{30{,}000 \times (230-5)}{5} = 1{,}350{,}000$ ohms.

The more common method is to use a Megger, which consists essentially of a direct-reading ohmmeter and a hand-driven direct-current generator, usually of 500 volts. The A.I.E.E. recommends: Insulation resistance tests shall, if possible, be made at a direct-current voltage of 500. Since the insulation resistance varies as the voltage, it is necessary that, if a voltage other than 500 volts is employed in any case, the other voltage shall be clearly specified." A Wheatstone bridge is sometimes used for making insulation resistance measurements.

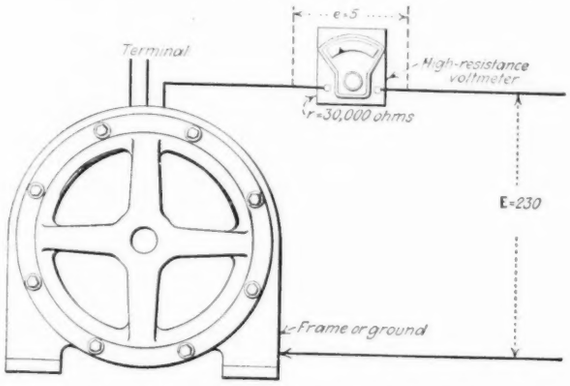


Fig. 7—Making insulation test with voltmeter

Our knowledge of the properties and the method of using various insulating materials has been greatly enhanced during the last few years. Design, methods of construction and operation of machines using insulation have kept pace with this progress. Present-day insulation can withstand satisfactorily fairly high temperatures and voltages and undergo severe mechanical strains. But it should be conceded that the quality and condition of the insulation of an electrical machine is the factor limiting its reliability and service. With this in mind every precaution should be taken to detect and prevent any conditions or defects in the insulation which will cause deterioration and ultimate breakdown. As a means of preventing failures in electrical machinery, there is probably no other feature that offers greater possibilities than does a careful check on insulation, and more attention is now being given to the insulation of electrical equipment by operating men than ever before.

Resistance to Flow of Air

Those who are interested in the flow of air in large ducts will find valuable information in Bulletin No. 261 of the United States Bureau of Mines, on the "Resistance of Metal-Mine Airways," by McElroy & Richardson.

This bulletin reports an extensive study of air flow, describes the instruments used, among them a draft gage reading to 0.0001 in. of the gage liquid and interesting types of Pitot tubes, and presenting the results of studies, showing the resistance in straight runs of various types of tunnels, the loss of head for turns and other special features, and finally presenting these results in the form of a chart from which resistance can readily be determined.

What Do You Know?

A SUBSCRIBER writes that an engineer should not attempt to judge his capabilities by answering the question "What do I know?" but, rather, the standard should be, "What don't I know?" This is hardly true, for if one can appreciate the fact that he does not know all about a certain point, he is in a fair way to gain complete knowledge. On the other hand, a confident declaration of "I know this" is of little value in rounding out one's education. There is a wide twilight zone of engineering knowledge in which our views are shadowy and uncertain. We "think we know" a great many things, and the list of questions following will probably concern some of these. See if your answers conform to those of the editor, which appear on page 88. Do not hesitate to call him if the answers appear incorrect; already several have been challenged. If you have a question of general interest, send it in and an attempt, at least, will be made to answer it in an early issue.

Ques. 1—Why are the rear tube ends of a fire-tube boiler not beaded?

Ques. 2—Who built the first commercial steam turbine?

Ques. 3—What is the difference between a two-stroke and four-stroke-cycle gas engine?

Ques. 4—What percentage of the piston stroke of a uniflow engine is taken up by the exhaust ports?

Ques. 5—Who invented the water-tube boiler having two horizontal drums connected by vertical straight tubes bent at the ends to enter the drums radially?

Ques. 6—What is a Dobrowolsky generator?

Ques. 7—Assume that a non-conducting vessel is partly filled with a mixture of ice and water at 33 deg. F. and that the vapor pressure in the vessel corresponds to a saturated temperature of 33 deg. F.; that is, 0.1878 in. of mercury. If heat be applied in just sufficient quantity to melt the ice, will the vapor pressure within the chamber remain at 0.1878 in. of mercury, or will it increase or decrease?

Ques. 8—What is the advantage of a divided windbox under a chain-grate stoker?

Ques. 9—For what suction lifts are centrifugal pumps usually designed?

Ques. 10—What is labyrinth packing and where is it used on steam turbines?

Cottland Plant, Sweden, Designed for High Pressure

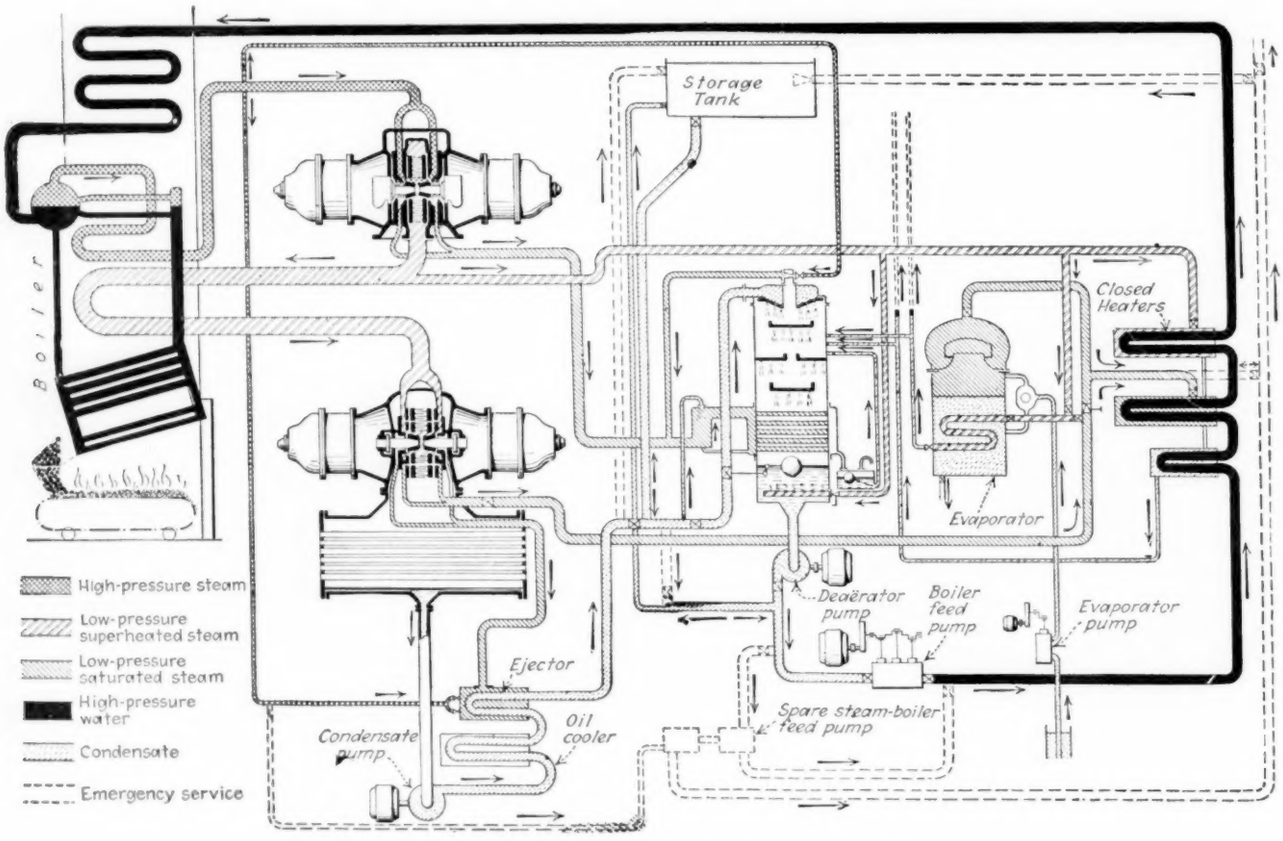
A NEW interesting high-pressure unit of 5,600 kw. capacity, recently installed in the Cottlands Power Plant at Slite, Sweden, is designed for a maximum steam pressure of 800 lb. per sq.in., though at present operation is only at 400 lb. pressure. The design makes it possible to adopt the higher pressure when load conditions require it, with but slight modification of the low-pressure turbine blading.

Steam is generated in two naval type boilers each having 2,420 sq.ft. of heating surface. At normal ratings each boiler generates 15,400 lb. of steam per hour, while at maximum rating each can deliver 25,000 lb. per hour. Two superheaters, one for high-pressure steam and one for low-pressure steam, are provided. Both superheat to a total temperature of 752 deg. F. A combination of air preheater and economizer reduce the heat loss in the flue gases.

A high-pressure 1,400-kw. Ljungstrom turbine designed to receive steam at 600 lb. pressure exhausts to a low-pressure turbine at 142 lb. The exhaust steam, however, is first reheated to 752 deg. F. The low-pressure Ljungstrom turbine has a maximum capacity of 4,200 kw. Both turbines, of the double-rotation type, are each direct-coupled to two three-phase generators.

The diagram clearly shows the steam and water cycles in the plant. Feed water is heated in small economizers, three closed-feed water heaters, and an open deaërator. The closed heaters receive steam bled from between the high- and low-pressure units and from overload channels of the low-pressure unit.

As may be seen in the diagram, the deaërator is of unusual design. The turbine condensate, slightly heated in passing through an air cooler and ejector condenser, is sprayed into the deaërating chamber. A vacuum is maintained in this chamber by a steam ejector, which also carries away any air that is liberated. The exhaust from the ejector mixes with steam bled from the high-pressure turbine and is used in closed tubes to heat the condensate as it is sprayed into the deaërator. The drips from these coils are collected in a vented tank from which the air removed by the ejector escapes, and the drips are returned to the deaërator.



Heat balance diagram for Cottlands power plant

Salt is removed from salt-water makeup in an evaporator supplied with steam bled from between the low- and high-pressure turbines. The vapor generated in the evaporator is condensed in one of the closed feed-water heaters.

The coal consumption of this unit was guaranteed at 3,000 kw. load and 100 per cent power factor to be 1.08 lb. per kw. when operating at designed steam conditions with a coal having 13,500 B.t.u. per lb. This coal consumption figure includes the power consumption of all auxiliaries for the boiler and turbo-generators, but not the steam used by the evaporators.

As the net connected load to the power station is not yet sufficient to enable operating at full load, complete tests have not been carried out. The result of preliminary tests are shown in the table.

PRELIMINARY PLANT PERFORMANCE

Boilers in service	1	2	2	2
Steam press, lb. per sq.in.	....	355	398	398
Temp. after high-pres. superheater, deg. F.	752	752	689	752
Temp. after low-pres. superheater, deg. F.	770	770	779	770
Total generated, kw.-hr.	14,100	....	30,720	....
Auxiliary power, kw.-hr.	1,470	....	1,285	....
Net output, kw.-hr.	12,630	20,020	29,435	32,000
Coal consumption per net kw.-hr. referred to 13,500 b.t.u. coal., b.t.u. per kw.-hr.	1.91	1.58	1.41	1.27
Load factor, per cent	17.5	28.8	42.7	44.5

From these preliminary results it is estimated that when generating 72,000 kw.-hr. of useful energy per day at an average load of 3,000 kw., the coal consumption would be 1.08 lb. per kw.-hr., which agrees with the guarantee. When considering these results, it should be noted that the auxiliary energy consumption includes energy required for station and office lighting and for driving some small machine tools. In addition, the load has varied during the day, which involves a higher coal consumption rate for the mean output.

Why Not Direct Young Men to an Engineering College?

By WILLIAM T. MAGRUDER*

WITH the demand for engineering graduates far in excess of the supply, why do not high schools and industries send to the engineering colleges more young men who are possessed of engineering aptitude, gumption and sense, in order that the colleges may train these young men to do the work that the industries must do in order to fulfill the demands of present-day civilization?

It is estimated that the industries need forty thousand new technically trained workers each year. The engineering colleges of this country are graduating annually only about eight thousand men, or only one man for five who are needed. Of the seventy thousand degrees conferred each year in our country, only one in nine is in engineering.

The demand is such that industry finds it necessary to use many hundreds of technically trained men and engineers who are attracted to us from Europe. Industrial managers have to try to get along with men who have been trained in less practical and less rigorous branches of learning. Some industries and corporations have been forced to establish, operate and finance their own trade and technical schools in order that they shall have a more adequate supply of technically trained employees. Few corporations can afford this expenditure. Most of them have to depend upon city and Y.M.C.A. trade and night schools and on the privately endowed and state-supported engineering colleges for their supply of such men.

Because of the increasing utility of engineering products for human needs and the corresponding demands for their construction, generation and efficient use, it is evident that there should be a large demand for trained engineers. These men now come from the colleges or along the slower and more laborious routes of practical training received in the industries. Reports for the last four years show that an average of seventy business organizations have applied directly to the Department of Mechanical Engineering of The Ohio State University asking each year for the services of 145 men from the graduating class, and that the classes have averaged only 45 men in mechanical engineering. Three positions for each graduate! For the 38 men of the class of 1926, 95 companies or corporations applied, requesting the services of 174 men as that university's quota of their needs.

Up to June 1, 38 companies had sent this spring 44 representatives to interview the twenty members of the graduating class in mechanical engineering. They have each spent from one to several days interviewing students. Each visiting personnel manager or educational director seeking men has had personal interviews with from several to a dozen senior students. Some companies have had the likely students visit the plants or factories at the expense of the company, spend the day, see the place, and be interviewed by some of the executives, before they actually offered employment to the student. Every effort is apparently being made to prevent mistakes. The practice of employing from one to several hundred college graduates, training them for a year or two, and then letting half of them go, has been found to be bad and is no longer followed.

DEMAND FOR COLLEGE GRADUATES EXCEEDS SUPPLY

What is true of the Department of Mechanical Engineering is equally true of the other engineering departments of that university and of the other engineering colleges of the country, with probably few exceptions. The demand for engineering college graduates far exceeds the supply. It is not at all unusual for a promising senior to have five or more offers of permanent positions with leading engineering corporations. There are few if any alumni available for employment. They are not easily moved. Rolling stones may exist in business, but not in the engineering profession.

Men who sneer at the present-day engineering graduates and say that they have no use for them either do not know the product of the engineering college or do not know how to use such raw material. Fortunately for the young men, other people can use them and train them to advantage to become their foremen, salesmen, superintendents, research experts and executives. An increasing number of kinds of industries are beginning to recognize the potential value of, and are finding uses for, the practically trained engineering-college graduate. Few, if any, colleges are now graduating "kid-glove engineers." Several companies have been spending from fifty to one thousand dollars a year visiting each of several engineering colleges to obtain its graduates for their employ, and have been doing it for a score and more of years, and are still doing it. If they are making a mistake, why don't they find it out?

Penurious parents, politicians and pessimistic people

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tell us too frequently that "we are educating far too many young persons." It may be true that the states are trying to educate too many boys and girls who are not going to school or college primarily to get an education, but only to have a good time, make contacts with other people, and for ulterior motives; but the statements is far from correct when it comes to educating young men for the engineering profession and training them for positions requiring much skill, technical knowledge and professional judgment. Industry needs and is asking each year for an increasing number of men of proper training, good judgment for their years, and with a little of that uncommon thing called "common sense," to whom it can give the special kind of training that is needed in its particular branch. Evidently, the industries should be provided with what they rightfully want and ask for and for which they are willing to pay. If an engineering college should lower its standard, the industries would find it out very quickly and seek elsewhere for the young engineers whose services they desire in order to train them for responsible and executive positions.

The kinds of young men needed for training in an engineering college out of which good engineers and executives may eventually be made are those who are absolutely honest with themselves and their associates, who are able-bodied and not weaklings, who have a love for mathematics and logical analysis, the physical sciences and accurate English, who have a high school education or its equivalent, who have some manual skill and delight to do things with their hands, and who are either intensely studious themselves or capable of leading others.

Money Not Necessary

Lack of money is no preventive to a boy's getting an education, who has the physical health, the mental ability and the personal ambition, and who does not have too many domestic responsibilities. All the recent engineering graduates of The Ohio State University have earned part of their college expenses, as they are now required to get into industry for at least one summer before beginning the work of their senior year. Twenty-five per cent of them are entirely self-supporting. Fifty per cent of them partly support themselves during the college year. Not a few of the older ones are married. The average age of the graduating classes in engineering is over twenty-four, and sometimes more, rather than less, as is the case in more academic studies.

Superintendents, foremen, chief draftsmen and other executives should use their influence with their young associates and suggest to them that they carefully consider the desirability of securing an engineering college education, knowing full well that seed so sown will bring forth much fruit, and by which they themselves are likely to be benefited. It is suggested that more large corporations finance scholarships at the colleges and pay part or all of the expenses of one or more young men in their employ who have shown their technical ability and have the desire for an education. Five to eight hundred dollars a year so invested in a wisely selected human machine is likely to pay good dividends in personal satisfaction and in service received. Memorial endowment funds of ten to fifteen thousand dollars in the stocks of the corporation would found such a scholarship, perpetuate a name, give a higher education to a worthy young man and act as an incentive to a number of others.

As engineering is the economic utilization of the forces of Nature and of human endeavor for the benefit of mankind, the field is a large one, its paths are numerous, its growth is prodigious, its beauties are great, its rewards are ample. Blessed is the young man who has a friend who will guide him into such a field of human endeavor where he can reap happiness and health, and a comfortable and honorable living, while advancing civilization.

Answers to What Do You Know*

Ans. 1—They should be. Most modern boilers follow the A.S.M.E. Code, which prohibits the use of projecting rear tube ends. The rear ends may be rolled and either beaded or welded, but must not project.

Ans. 2—Sir Charles Parsons is credited with the first commercial turbine.

Ans. 3—A complete cycle of admission, ignition, expansion and exhaust is accomplished in two strokes of the two-stroke-cycle, and in four strokes of the four-stroke-cycle engine.

Ans. 4—Approximately 10 per cent of the stroke is occupied by the exhaust ports.

Ans. 5—The type of boiler is generally conceded to have been invented by Milne.

Ans. 6—A three-wire direct-current generator in which the neutral connection is obtained through a balancing coil connected to the armature.

Ans. 7—When the ice melts, the resulting volume of liquid is less than the volume of ice; consequently there is an increase in the volume occupied by the vapor which expands, lowering the pressure slightly. This in turn causes some of the water to flash into water vapor, but the pressure remains slightly less than before the ice melted.

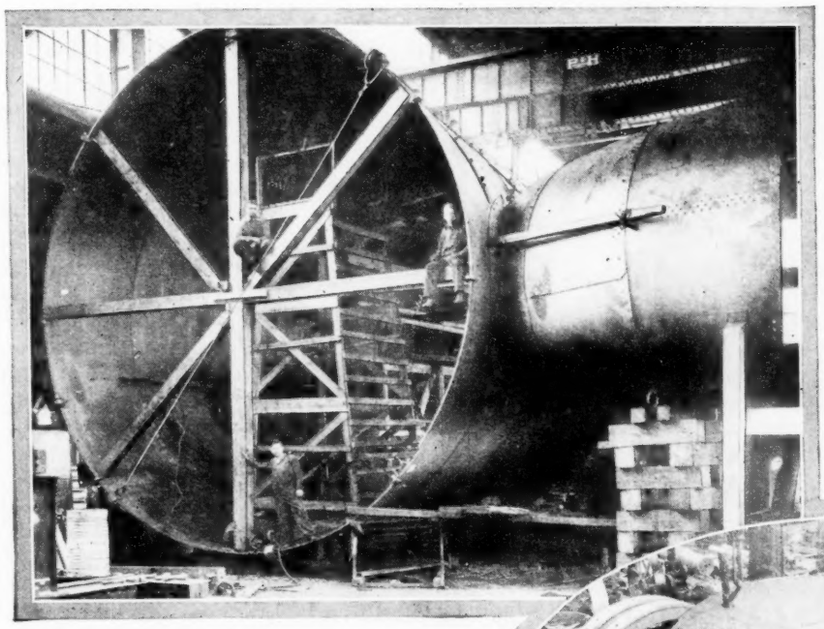
Ans. 8—The use of several wind compartments permits better control of the combustion of the fuel on the grate surface. It also gives better combustion at low loads by enabling the coal to be burned on a part of the grate surface only.

Ans. 9—A suction lift 16 ft. is commonly used in pump design.

Ans. 10—Labyrinth packing is a type of packing used to prevent the leakage of a fluid through the clearance space between a stationary and a moving element. The principal application is in sealing turbine shafts where they pass through the casing. Labyrinth packings are of many types, but in general they consist of an assembly of relatively light elements, so devised that fluid leaking through must pass through many small clearances, which reduce the amount of leakage. Such packings may be used to prevent steam escaping from the head end of a turbine, or to prevent air leaking into the exhaust of a condensing machine. A labyrinth packing does not stop leakage altogether, but reduces it. The packing strips are made thin and light so that if they do chance to rub, the heat generated will not be sufficient to damage the machine. The light strips will wear away easily. A labyrinth packing is often provided with an intermediate draw-off chamber, from which leakage is taken to a condenser or water heater. Sometimes a water seal is added to prevent external leakage altogether.

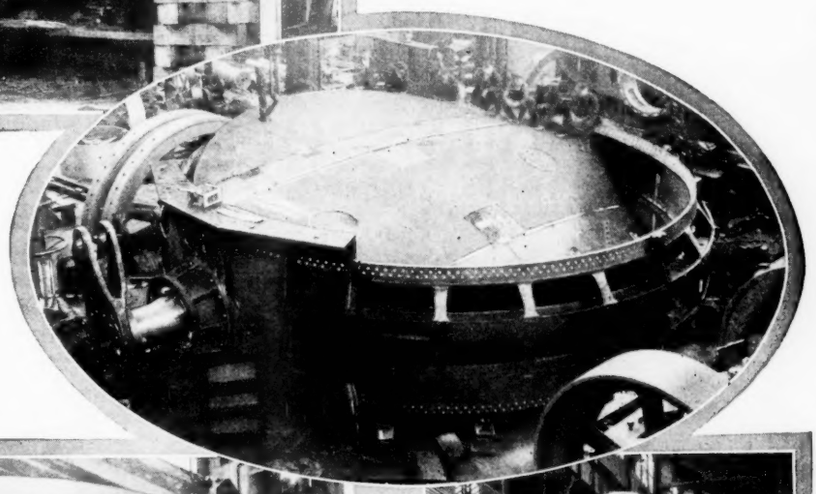
*The questions to which these are answers may be found on page 85.

Conowingo Waterwheels and Valves Nearing Completion



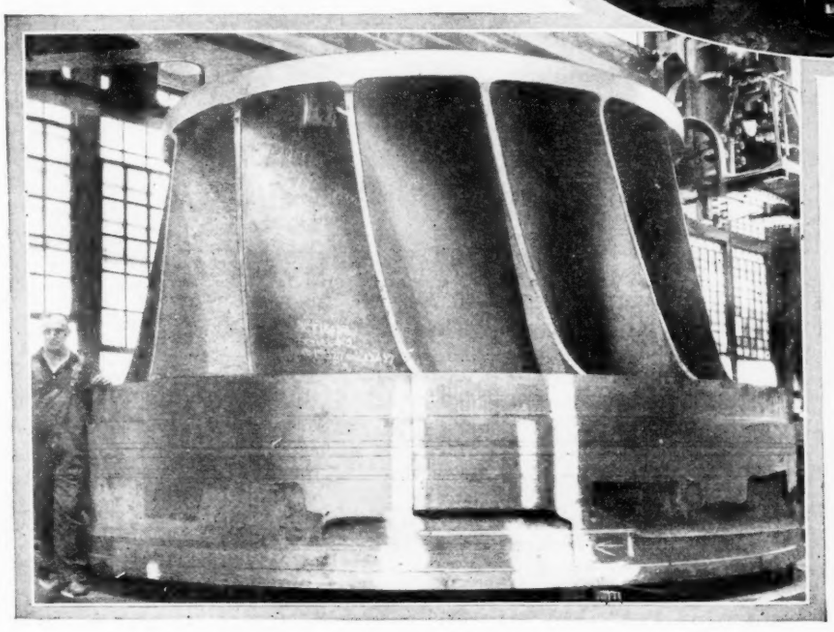
Left—Plate-steel spiral casing for one of the waterwheels in the Conowingo development of the Susquehanna Power Co. The entrance to this casing is 27 ft. diameter and the over-all width of the casing is 65 feet

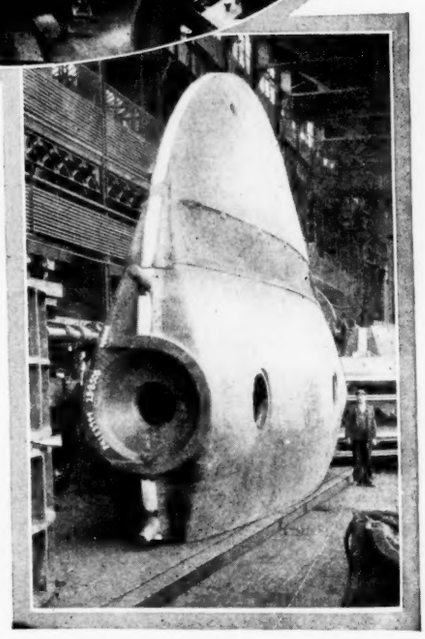
In the oval and lower right are shown two views of the butterfly valves that are to be installed in the penstocks. These valves will serve for double duty as shut-off valves for the waterwheels and as head gates in the penstocks. The wickets are cast in three pieces and when assembled weigh about 120 tons

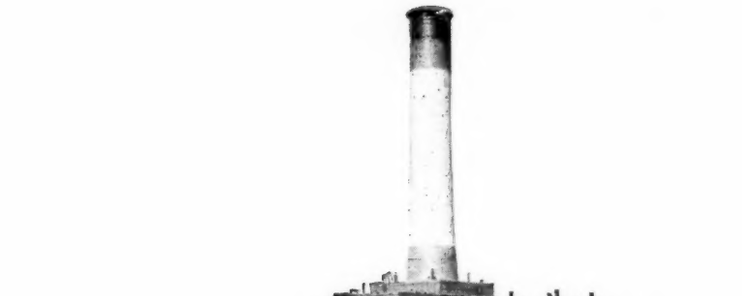


Below—One of the 60,000-hp. runners to operate under a maximum head of 97 ft. Its largest outside diameter is 16 ft. 8in., it is built in three pieces and weighs over 200,000 pounds

Photos by courtesy of the Allis-Chalmers Manufacturing Co., which is building four of the waterwheels and valves.







Feed Water for World's Largest Boilers Receives Zeolite and Acid Treatment*

RECENT developments in boiler design and firing methods have made possible great increases in rates of driving, with consequent reductions in investment costs. Most of these developments have originated in electrical generating stations using distilled water or at least a high percentage of recirculated water. In a central heating plant the advantages of high steaming rates are at least equally great, but the necessarily large amount of makeup water in such a plant (very little condensate being returned from the consumer's buildings) makes difficult the successful attainment of such steaming rates. Under these conditions feed-water treatment is of primary importance, and if, through the production of a better water, any particular method of treatment makes higher steaming rates possible, then the reduction thus brought about in the entire plant investment far overbalances any possible increased cost of installing and operating the treating system.

The Beacon Street heating plant is the newest of the four plants that supply steam for heating in the central business district of Detroit. It is designed to contain twelve boilers, each of 41,500 sq.ft. of heating surface, capable of being operated at 300 per cent of rated capacity to give a total steam output per unit of 406,000 lb. per hour. These boilers are the largest yet built as to evaporating surface, though not as to steam output.

Makeup water comes from the city water mains. The Detroit water supply is taken from the Detroit River and is filtered. A typical analysis (March, 1926) is as follows: Parts per million—Co_2 (free), 1.8; SiO_2, 6.4; Fe_2O_3, 2.0; Ca, 25.7; Mg, 7.3; Na and K, not determined; HCO_3, 75.6; Co_3, 0.0; SO_4, 31.1; CL, 7.7; total solids by evaporation, 121.0. This is a rather soft water and external treatment had never been considered in the existing heating plants, operated at lower steaming rates, although internal treatment with sodium carbonate had been used for several

TO PREVENT scale formation in boilers operating at 300 per cent rating when fed with 90 per cent makeup, Zeolite softening was selected and followed by a treatment of sulphuric acid, to reduce the high caustic alkalinity in the Zeolite water. The use of additional acid in the form of phosphoric acid diminished prospects of corrosion in the customers' radiators and pipe lines by decreasing the amount of carbon dioxide gas in the steam leaving the boilers. Other features of interest are an exact acid proportioning device and a continuous blowoff system.

*Extracts from paper presented at annual convention of the American Water Works Association, Chicago, June 8, 1927. Authors: Alfred H. White, professor of chemical engineering, University of Michigan. J. H. Walker, assistant to the chief engineer, Detroit Edison Co. Everett P. Partridge, Fellow in Chemical Engineering, University of Michigan. Leo F. Collins, chemist, Detroit Edison Co.

years, but did not entirely eliminate scale.

In the selection of a treating system for this heating plant the primary consideration was that it produce as nearly as possible a scale-free water. A deposit of scale of even eggshell thickness in boiler tubes that are directly exposed to severe radiant heat will so impede heat transfer as to cause overheating and failure of the tube wall; and it is the unfortunate characteristic of the worst scale-forming materials that their decreasing solubility with increasing temperature causes them to precipitate on these hottest tube walls.

Other Methods Were Considered

Consideration was given to several methods of treatment before the selection of Zeolite was finally made. As chosen, the Zeolite system is open to the theoretical objection that it does not remove the dissolved solids, but merely converts them to more soluble salts, thus causing high concentration of solids in the boiler and requiring a large amount of blowoff. Another objection is that with a bicarbonate water such as that in Detroit, the sodium bicarbonate produced by the treatment, unless removed by an after-dose of acid, would ultimately cause a high caustic alkalinity in the boiler. As a means of preventing scale formation, however, it appeared that the Zeolite system would be certain of results and operating experience has confirmed this conclusion. With the calcium and magnesium almost totally removed, the potential scale-forming elements are largely disposed of and the possibility of the small residue of these materials depositing as sulphate scale is probably prevented by the presence of sufficient carbonate ions.

The large amount of blowdown is prevented from being a serious source of heat loss by the continuous ex-

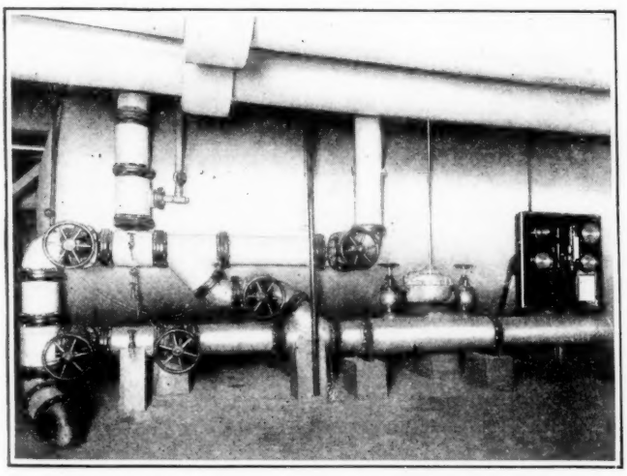


Fig. 1—One of the Zeolite softening tanks

traction of a small amount of water which is passed through a heat exchanger, where the heat is transferred to the colder supply water. The waste of the water itself, however, cannot be economically prevented.

Reasons for Acid Treatment

The high caustic alkalinity in the boiler resulting from the use of a Zeolite system with a water that is high in bicarbonate demands consideration of the possibility of embrittlement of the boiler steel. Although no attempt was made to pass judgment upon this as yet unsettled point, it was thought prudent to add the required quantity of inhibiting sulphate ions suggested by Professor Parr and others. For this reason the plan was adopted of treating the water after passage through the Zeolite bed with a carefully graduated quantity of sulphuric acid.

There was a further requirement imposed upon the treating system which would be met by the use of this acid feed. With a bicarbonate water the steam leaving the boiler is ordinarily contaminated with carbon dioxide,

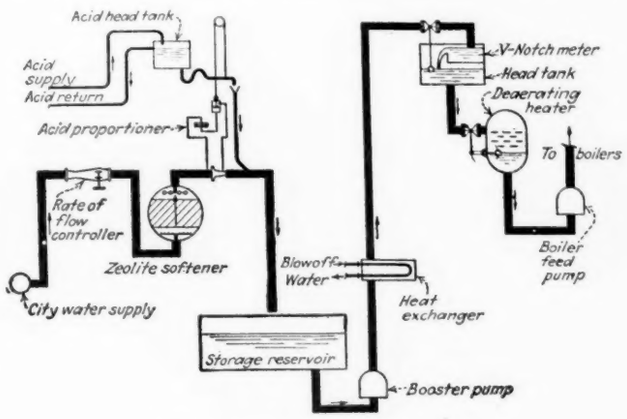


Fig. 2—Diagram of the water cycle

and one of the objects sought was the reduction of this gas content. The slow corrosion which has occasionally been observed in the pipes and radiators of consumers' heating systems has been thought to be partly due to the presence of this gas along with oxygen, and there is some evidence to support this view. The addition of acid to the Zeolite-treated water would serve to liberate an equivalent amount of carbon dioxide, and if the water were passed through a deaërator before going to the boiler, the free carbon dioxide would be removed along with the oxygen. Some of the remaining bicarbonate also would be broken up.

Sulphuric Acid More Effective Than Sulphate Salt

The addition of sulphuric acid is more effective in increasing the sulphate-carbonate ratio than would be the addition of a sulphate salt, because it removes carbonate ions as well as adding sulphate ions; and although the primary purpose of the acid is to reduce the caustic, its use also makes it possible to reduce the carbon dioxide content of the resulting steam approximately in proportion to the amount of acid fed. The use of acid following a Zeolite treatment is not new, but the method of application possesses some novel features, and it has probably not been used heretofore on such a large scale or accompanied by quantitative studies of its effects.

The limits to the amount of acid to be fed could not be set clearly from theoretical considerations. There were two points to be guarded against in the introduction of sulphuric acid—the danger of corrosion due to an acid water, and the possibility of depositing a sulphate scale if the concentration of the carbonate was reduced to too low a point. The use of phosphoric acid offered some attractive possibilities as a supplement to sulphuric acid because of its lesser corrosive action and the flocculent nature of calcium phosphate which does not form a hard scale. The obvious disadvantage of phosphoric acid lay in its higher cost.

Most elaborate preliminary investigations to determine the possibilities of the removal of carbon dioxide from a

Zeolite-treated water by means of sulphuric and phosphoric acids were made in the laboratories of the University of Michigan and the results reported in the paper by Prof. Alfred H. White. It will suffice to say that the findings were adopted and put into practice in the plant with highly satisfactory results.

The Treating System at the Beacon Street Plant

The Zeolite tanks are 10 ft. in diameter and 25 ft. long, set with their axes horizontally, and are constructed on the upward-flow principle. The Zeolite is of the green sand type, having a rated exchange value of 3,375 grains per cubic foot. The Zeolite bed is 41 in. thick and the rate of flow at normal load is 35 lb. of water per min. per square foot of bed area. The total output per tank is 3,700,000 lb. between regenerations at the rate of 530,000 lb. per hour normal flow and with a maximum permissible flow of 620,000 lb. per hour. There are two of these tanks in the initial installation, one of which is shown in Fig. 1, and the completed boiler plant will require a total of six tanks. The brine required for regeneration is supplied to the Zeolite tanks through a simple piping system from a central overhead tank.

Water under city pressure flows through the Zeolite

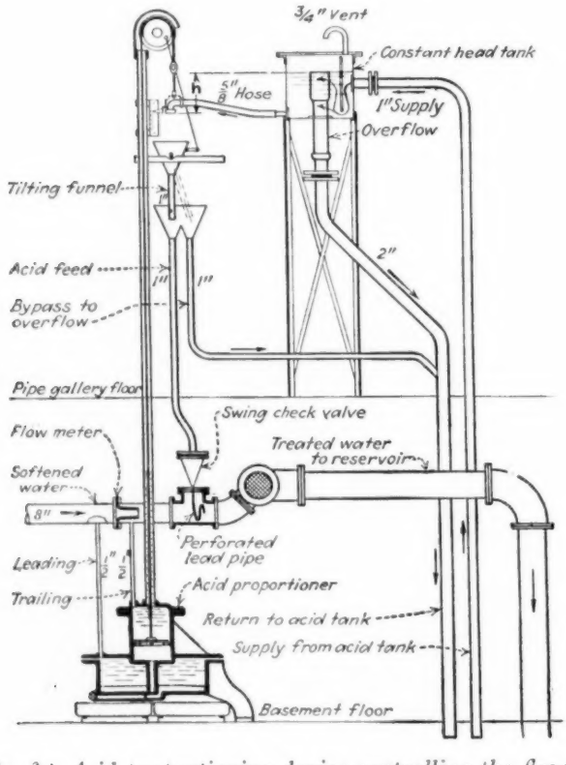


Fig. 3—Acid proportioning device controlling the flow of dilute acid in exact proportion to the water flow

tanks. To insure the constant rate of flow that is essential in an upflow system, regardless of fluctuations in pressure, a Venturi-type flow controller is installed. After leaving the Zeolite tanks, the water is treated with acid and then flows into a concrete storage reservoir, see Fig. 2. Booster pumps lift it to a head tank from which it flows by gravity to the deaërating heater and boiler-feed pumps. The heater contains a large number of trays over which the water flows and is swept by a counter-current of steam which removes the dissolved gases completely.

Acid Feeding System

Dilute acid in exact proportion to the amount of water treated is fed by the acid proportioning device. Although the water flow is maintained approximately constant by the controller and a fixed rate of acid feed might therefore have sufficed, it was nevertheless felt necessary to adjust the acid feed exactly and to provide an automatic

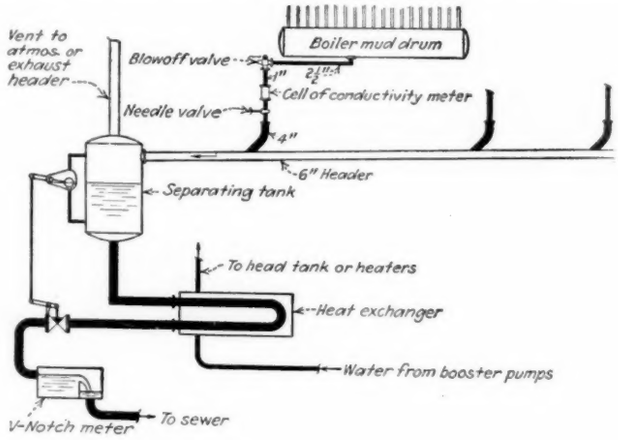


Fig. 4—Diagrammatic arrangement of continuous blowoff system

means of cutting off the feed when the flow of water stops. The proportioning device shown in Fig. 3 was therefore developed.

Before being used, the acid is diluted to a 2 to 3 per cent solution in a central tank and is pumped through lead-lined pipe to a constant level tank at each Zeolite softener. To the bottom of each tank is connected a piece of rubber hose with a small orifice at its end, the elevation of which, with respect to the level in the tank, marked *h* in Fig. 3, is controlled by a float resting on a column of mercury. This mercury level is controlled by a Venturi nozzle placed in the water pipe leaving the softener. There is no stuffing box required and the float moves with practically no friction. Since the flow of acid through the orifice and the flow of water through the Venturi throat are governed by a square root law, the device gives almost exact proportioning, the only error being caused by the deflection of the lower leg of the mercury U-tube, and this is made negligible by the relatively large diameter of this chamber.

To give the proper feed-water conditions, the strength of the acid solution is adjusted. At present a 3 per cent solution is used and the ratio of the acid to the total boiler feed is about 35 parts of 100 per cent H_2SO_4 per million parts of water. The condition of the water is recorded by a Leeds & Northrup hydrogen ion recorder which shows the pH value of the water in the storage reservoir and also as it leaves the feed-water heater. This apparatus is checked frequently by means of LaMotte colorimetric indicators. It is expected that after more experience is gained, this apparatus can be dispensed with.

Continuous Blowdown

At Beacon Street the blowdown amounts to about 4½ per cent of the total boiler feed. The use of a continuous blowdown makes possible the extraction of

the heat from the water and also gives more uniform steaming conditions than would the intermittent blowing off of large quantities of water. The arrangement of the blowdown system is shown diagrammatically in Fig. 4. From each of the two mud drums of each boiler there is provided a 1-in. line with a needle valve for controlling the flow. As the water passes through the needle valve, there is naturally a considerable amount of steam flashed off, and this mixture of steam and water is conducted through pipes of generous size to a separating tank, from which the steam is vented into the exhaust system of the plant carrying a pressure of about 2 lb. gage.

From the separating tank the water flows through a

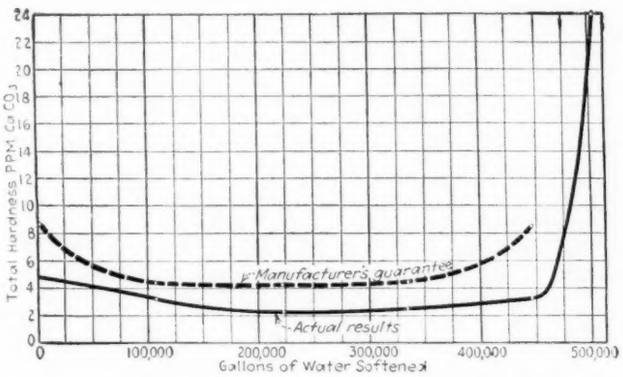


Fig. 5—Condition of Zeolite-softened water at various intervals during a run on one tank

heat exchanger and V-notch meter and thence to the sewer. A float-controlled valve regulates the flow so as to maintain a constant water level in the separating tank. The cold supply water on its way to the heater passes through the heat exchanger, absorbing heat from the blowoff water.

The amount of blowdown is determined by a Leeds & Northrup recording conductivity meter, the cell of which is in the blowoff line ahead of the needle valve. The electrical conductivity of the solution of salts in the boiler is a measure of the concentration, provided the kind of dissolved materials and their relative amounts with respect to each other remain the same. At present the concentration of dissolved solids is kept between 2,000 and 3,000 parts per million, and the corresponding conductivity is from 3,400 to 3,700 reciprocal megohms. This standard has been established by experience with this particular water composition and boiler design. Further experience may permit the concentration to be increased.

Operating Results

Since September, 1926, the system has been in operation. In general the desired results have been obtained. The maximum boiler loads for which the plant is designed were not called for during this first winter of operation, but under existing load conditions, calling at times for 250 per cent rating, there was no tube trouble and no formation of scale in the boilers.

The Zeolite system produces water with an average hardness, expressed as $CaCO_3$, of less than three parts per million, this being somewhat better than the manufacturer's guarantee. The results of analyses of samples taken at various times during a run on one tank are shown in Fig. 5.

Table I shows the analyses of the water before and after treatment, and Table II shows the condition of the water at several points in the cycle, using a feed of 35 parts per million of H_2SO_4.

The acid feeding methods have worked out satisfactorily. Close supervision has been maintained, and of course an acid feed will always require careful handling, but given such supervision, there appears to be no danger of an overdose of acid. There has been some trouble with the acid pumps and piping system, which is no doubt due to lack of experience with this kind of equipment. It appears that the lead-lined pipe is not entirely immune from attack by the dilute acid, and the acid pumps have not been entirely satisfactory.

With the normal feed of 35 parts per million of H_2SO_4, the pH value of the water immediately after the acid feed is low (6.4), but after the water is passed

TABLE I—WATER CONDITIONS BEFORE AND AFTER TREATMENT
All figures in parts per million

Cations	Raw Water	After Zeolite	After Acid Feed and Deaeration
Silica	3.0	5.1	5.1
Iron oxide and alumina	2.0	0.7	0.7
Calcium	26.4	0.8	0.8
Magnesium	6.4	0.2	0.2
Sodium	3.8	45.0	45.0
Anions			
Sulphate	20.1	20.1	54.0
Chloride	5.9	5.9	5.9
Bicarbonate	87.0	87.0	27.5
Carbonate	0.0	0.0	9.0
Total dissolved solids	154.6	164.8	148.2
Hardness as $CaCO_3$ (gravimetric)	92.25	2.74	2.74

TABLE II—WATER CONDITIONS AT VARIOUS POINTS IN THE CYCLE*
Quantities in parts per million unless otherwise stated
Acid feed—35 parts of 100 per cent H_2SO_4 per million parts of water treated

	Raw Water	After Zeolite	After Acid Feed	After Deaerator	In Boiler	Steam
Temperature, deg. F.	40.0	40.0	40.0	215.0	365.0	365.0
Pressure lb. gage	45.0	7.5	.....	.....	155.0	.....
pH value	7.6	8.6	6.4	8.5	.....	5.4
CO_2 (free)	1.8	.....	18.1	0.0	0.0	25.0
O_2 c.c. per liter	6.03	6.03	6.03	0.016	.....	0.04v
$NaHCO_3$	0.0	120.0	60.5	38.0	.....	.....
Na_2CO_3	0.0	0.0	0.0	14.2	174.0	.....
Na_2SO_4	0.0	30.0	81.0	.....	1500.0	.....
NaOH	0.0	0.0	0.0	0.0	360.0	.....
Total alkalinity as Na_2CO_3	.....	.....	.....	.....	650.0	.....
Na_2SO_4	.....	.....	.....	.....	2.3	.....
Total alk. as Na_2CO_3	.....	.....	.....	.....	10.0	.....
Ratio SO_4 to CO_3						

*Average of 11 half-hourly readings.

through the deaërator, it is increased to 8.5, owing to the removal of the carbon dioxide, so that the water going to the boilers is well on the alkaline side. Referring to Table II, it will be noticed that the acid reacts completely before the water enters the deaërator. The sodium bicarbonate is reduced from 120 to 60.5 parts per million by this reaction. In the deaërator the sodium bicarbonate is reduced from 60.5 to 38 parts per million, a reduction of 37.2 per cent, producing an equivalent amount of normal sodium carbonate. This result is somewhat better than obtained in the laboratory, and although further removal of carbon dioxide probably could be accomplished by steam treatment, it would hardly be justified and is not contemplated.

The ratio of the sodium sulphate to the total alkalinity expressed as Na_2CO_3 is also shown in Table II. The suggested minimum value for this ratio for the steam pressure in this plant is 1.0, so that the figure of 2.3 is well on the safe side. The maximum sulphate-carbonate ratio permissible under Doctor Hall's theory is 11.1, whereas the ratio actually maintained is 10. An increase of sulphuric acid feed would make the sulphate-carbonate ratio reach the value at which sulphate scale, in minute quantities, might be formed, and a decrease in

the acid feed would bring the sodium-sulphate total-alkalinity ratio toward the danger line of caustic embrittlement. There is, evidently, between these two somewhat conflicting requirements a margin in which it is possible to stay.

Results with Phosphoric Acid

As a pure experiment to determine the possibilities of further decreasing the CO_2 content of the steam, some phosphoric acid was used for a short period in addition to the sulphuric acid. The results are shown in Table III. With a feed of 41 parts per million of H_2SO_4 plus 24.6 parts per million of H_3PO_4 the carbon dioxide in the steam was reduced to 12 parts per million. The pH value of the water after the acid treatment was 5.8, and that of the condensed steam was 5.4. Although the sulphate-carbonate ratio is above the limit suggested by

TABLE III—WATER CONDITIONS WITH PHOSPHORIC ACID FEED*

Quantities in parts per million unless otherwise stated
Acid feed 41 parts of 100 per cent H_2SO_4 plus 24.6 parts of 100 per cent H_3PO_4 per million parts of water treated

	Raw Water	After Zeolite	After Acid Feed	After Deaerator	In Boiler	Steam
Temperature, deg. F	40.0	40.0	40.0	215.0	365.0	365.0
Pressure lb. gage	45.0	7.5	7.5	.....	155.0	155.0
pH value	7.6	8.4	5.8	8.8	.....	5.4
CO_2 (free)	1.8	1.8	18.1	0.0	0.0	12.0
O_2 c.c. per liter	6.03	6.03	6.03	0.016	.....	0.044
$NaHCO_3$	0.0	116.0	24.2	14.6	0.0	.....
Na_2CO_3	0.0	0.0	0.0	4.1	143.0	.....
Na_2SO_4	0.0	30.0	88.5	77.5	1600.0	.....
NaOH	0.0	0.0	0.0	0.0	70.0	.....
NaH_2PO_4†	0.0	0.0	30.0	26.2	0.0	.....
Na_2HPO_4	0.0	0.0	0.0	0.0	225.0	.....
Total alkalinity as Na_2CO_3	.....	.....	.....	.....	236.0	.....
Na_2SO_4	.....	.....	.....	.....	6.8	.....
Total alk. as Na_2CO_3	.....	.....	.....	.....	13.2	.....
Ratio SO_4 to CO_3	.....	.....	.....	.....	7.1	.....
Ratio SO_4 to PO_4	.....	.....	.....	.....		

*Average of ten half-hourly readings.
†These combinations are calculated in the conventional manner and do not attempt to indicate the exact combinations which are present in the solution.

Doctor Hall, the presence of PO_4 would prevent the formation of sulphate scale. The PO_4 content is 150 parts per million, whereas a concentration of somewhat more than 4 parts per million should be sufficient.

These results indicate that it is entirely possible to control the carbon dioxide content of the steam by varying the acid feed and that the use of phosphoric acid for this purpose appears quite feasible, although experience with it has been limited.

Conclusions

The Zeolite water softening system operates satisfactorily, and the acid feed, with careful supervision, appears to be quite practicable and reasonably safe.

The addition of sulphuric acid sufficient to neutralize about 50 per cent of the $NaHCO_3$ in the Zeolite treated water gives a pH value of 6.4 to the water entering the deaërator and a pH value of 8.5 to the water leaving the deaërator and entering the boiler.

The water leaving the deaërator has lost all the CO_2 set free by the acid, and the amount of $NaHCO_3$, which was 60.5 p.p.m., dropped to 38.5 p.p.m. after the acid treatment.

The continuous blowdown through a heat exchanger is satisfactory and the system of ionic control is effective.

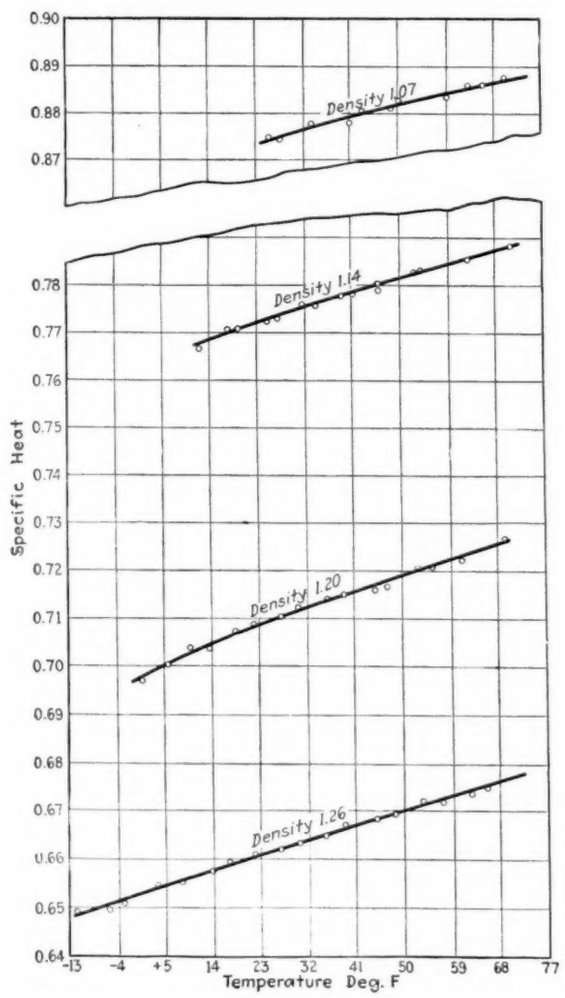
The ratio of sodium sulphate to total alkalinity is believed to be amply safe with the amount of H_2SO_4 added.

Inspection of the boiler after eight months of operation has revealed clean tubes and no serious corrosion. There have been no tube burn-outs.

It has been demonstrated that the use of additional acid in the form of phosphoric acid gives less carbon dioxide in the steam and less caustic alkalinity in the boiler. The necessity for reducing the carbon dioxide is not certain and will be justified only if the steam shows itself later to be corrosive with the smaller amount of acid feed. If scale ultimately appears in the tubes when only sulphuric acid is used, it is believed that the addition of a small amount of phosphoric acid will eliminate it.

Specific Heat of Calcium Chloride

Many times it has been impossible to calculate closely the refrigerating duty performed by a plant under test, by reason of the fact that the actual specific heat of the brine was not known accurately. The Bureau of Standards has prepared the specific heat chart reproduced in the illustration. It will be noticed that between a brine of 1.26 density and one of 1.07 the specific-heat variation is about 20 per cent.



Variation of specific heat of calcium chloride

While the curves refer to special grades of calcium chloride, the variation due to difference in brands, etc., is but slight. With this chart before him the refrigerating engineer can determine accurately the plant's duty and efficiency.

Evaporation Factor Easily Found with This Chart*

By C. A. KULMANN†

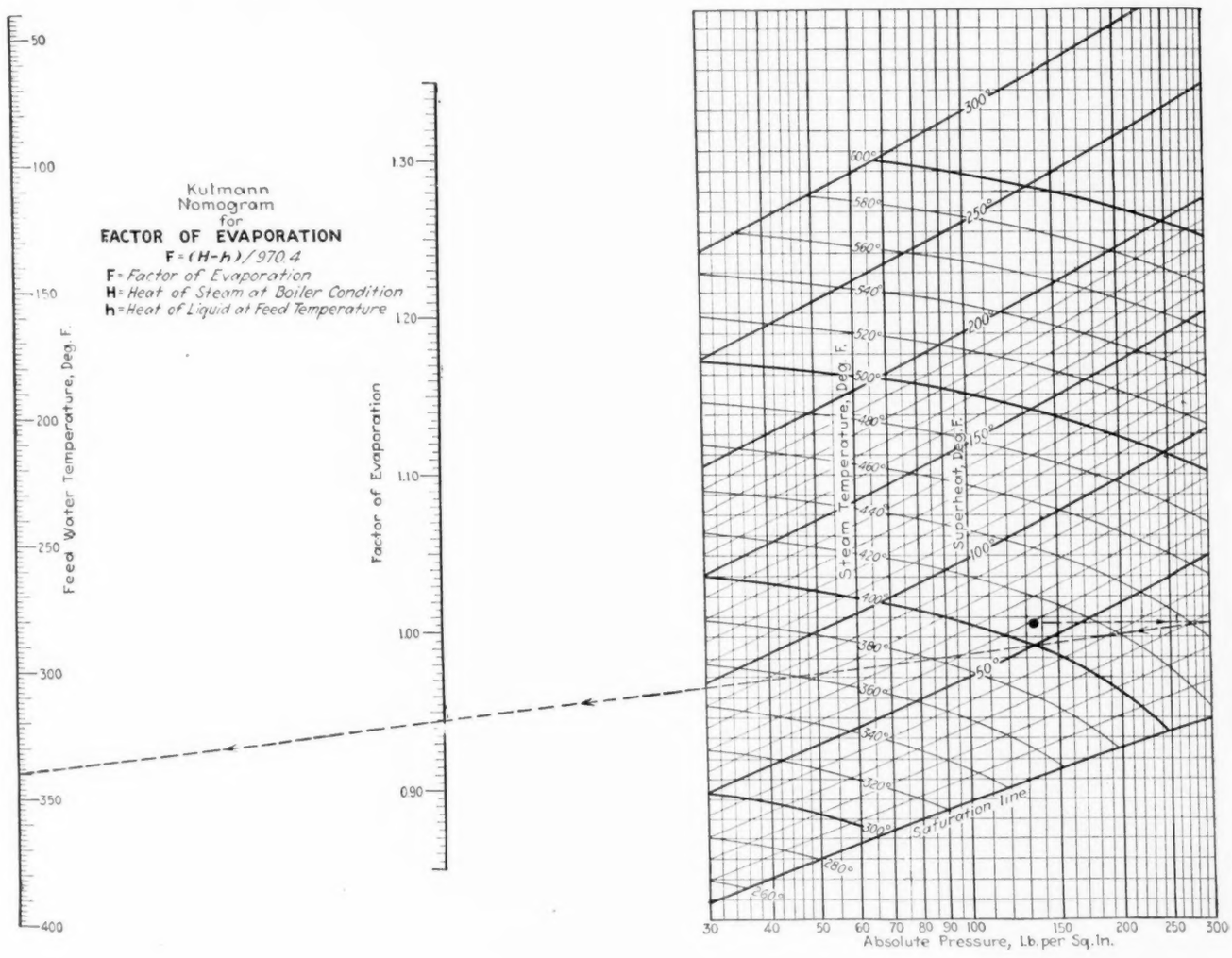
ACCORDING to the A.S.M.E. Boiler Code the unit by which the capacity of a boiler is measured is the evaporation of one pound of water per hour into dry steam "from and at" 212 deg. F.[1] This requires the addition in one hour of the latent heat of evaporation of one pound of water at 212 deg., this amount of heat being equal to 970.4 B.t.u.

The factor of evaporation is the ratio existing between the amount of heat added to the water (under actual conditions at the beginning and end of the process) and the unit mentioned above. Mathematically expressed, this relation is $F = (H - h) \div 970.4$, where F is the factor of evaporation, h the total heat per pound of water at feed temperature and H the total heat per pound of steam at boiler conditions of pressure and superheat. The factor of evaporation may be quickly found from the accompanying chart without referring to the steam tables.

In using the chart, a point is first found where the vertical line corresponding to boiler pressure in the right-hand graph intersects the line of the existing degree of superheat (lines slanting upward to the right) or the line of actual steam temperature (slanting upward to the left).

From this intersection move horizontally to the right edge of the graph, from which point a straight-edge is laid to the feed-water temperature on the left-hand scale. This straight-edge will cross the middle scale at the factor of evaporation for observed steaming conditions.

For example, suppose the boiler pressure is 135 lb. absolute, the initial superheat 60 deg. F., and the feed temperature 340 deg. The solution is indicated by the dotted line. In the right-hand graph locate the intersection of the vertical line for 135 lb. pressure and the slanting line for 60 deg. of superheat. From this intersection, indicated by the black spot, follow horizontally to right-hand edge of graph. From this point line up a straight-edge to 340 deg. on the left-hand scale. This crosses the center scale at 0.945, which is the desired factor of evaporation.



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†Consulting Engineer.

[1]It should be mentioned that the A.S.M.E. Power Test Codes also recommend the use of a unit known as the Unit of Evaporation, which is, by definition, 1,000 B.t.u. This substitution of 1,000 instead of 970.4 simplifies calculations, and is favored by many progressive engineers.—Editor.

Oil Sprays for Fuel-Injection Engines*

An Outline of Work Carried On at Langley Field—Motion Pictures Show the Process of Oil-Spray Formation —Influence of Nozzle Design Discussed

By Edw. G. Beardsley

THE study of the solid-injection type of engine, with regard to its possible development for aircraft use, was started at the Langley Memorial Aëronautical Laboratory at Langley Field, Va., in 1921. The general problem was analyzed and an attempt made to attack it from all angles.

One of the things about which actual knowledge was desired was the characteristics of spray from injection valves. While the fit between the spray and the combustion chamber is not of much importance in the case of a low-speed, low-capacity engine, it is vital for the high-speed, high-capacity aircraft engine. The spray was therefore to be studied with regard to its penetration, general shape and atomization when injected into dense air.

It was thought that the method by which it would be possible to obtain the greatest amount of information about oil sprays was to take high-speed motion pictures of their start, development and cutoff, which would show their penetration, general shape and possibly their atomization. With this end in view preliminary apparatus was designed, built and tested during the summer of 1921, and in the fall of 1924 the photography of oil sprays in dense air became a reality. From that time to the present day much improvement has been made in the apparatus and methods, and considerable knowledge has been gained concerning the several factors governing the characteristics of oil sprays.

Design of Spray Nozzles

The injection valves studied include mechanically operated valves and automatic-injection valve especially developed for high-speed operation. The sprays are discharged from round orifices with or without directing impact surfaces and through annular orifices. Spiral grooves with helix angles of from 23 to 90 deg. have been used to break up the spray by means of centrifugal force. The former groove angle gives a spray to which about the maximum amount of centrifugal force practicable has been applied, while the latter gives a non-centrifugal spray.

Fig. 1 shows a complete spray from an injection valve employing medium centrifugal force. The injection pressure was 8,000 lb. per sq.in., and the chamber-air pressure was 200 lb. per sq.in. The actual penetration of the moving spray in inches and the time in thousandths of a second from the start of injection are given by the scales. The start of cutoff is marked.

Influence of Nozzle Shape

The end of the spray after cutoff appears somewhat like a corkscrew. This spiral appearance is probably caused by whirling of the oil drops which have passed around the spiral grooves inside the valve, and seems to continue after the oil has left the valve in spray form. It will be noticed that the spray seems to have lost its motion in the last few pictures, especially at the nozzle, where the spray is practically hanging motionless in mid-air.

The penetration-time values were plotted from data computed from measurements of the spray images on each film, taking into account the film speed and photographic reduction, as has been done in computing the scales on the aforementioned pictures. Spray volumes were also computed, by summation of the differential cylinders making up each spray.

In Fig. 2 is shown a non-centrifugal spray from a cylindrical orifice injected at 8,000 lb. per sq.in. pressure into the atmosphere, while in Fig. 3 the spray was injected into 200-lb. per sq.in. air pressure. The sprays appear somewhat like fir trees with drooping branches. This is because the velocity of the drops of oil is practically zero at the outside of the spray and increases toward the center. The oil seems to shoot out through the center and spill over on the sides, much like a foun-

*Abstract of paper read at the Spring Meeting of the American Society of Mechanical Engineers, White Sulphur Springs, W. Va., May 23, 1927.

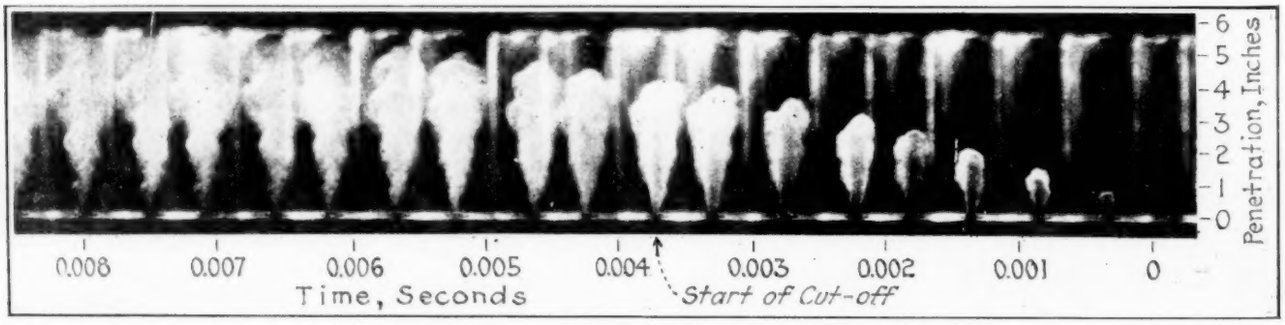


Fig. 1—Spray from a centrifugal nozzle, showing penetration and duration of the spray

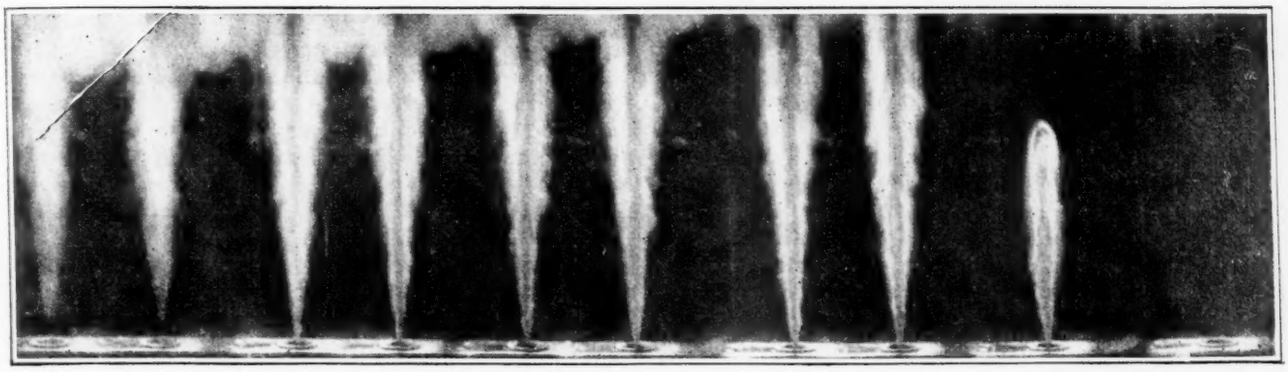


Fig. 2—A non-centrifugal 8,000-lb. spray injected into the chamber with the latter under atmospheric pressure

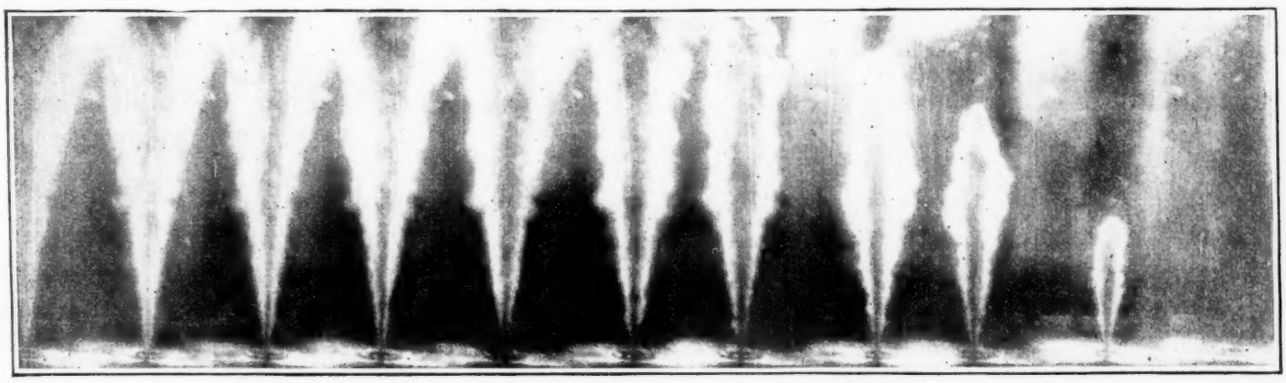


Fig. 3—The same spray as in Fig. 2 with the chamber at 200-lb. pressure

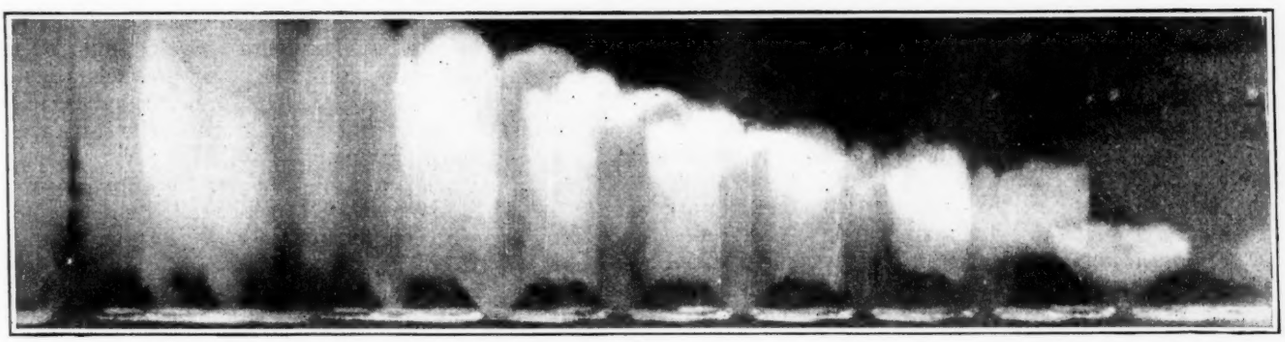


Fig. 4—Formation of a high-centrifugal spray injected into atmospheric pressure

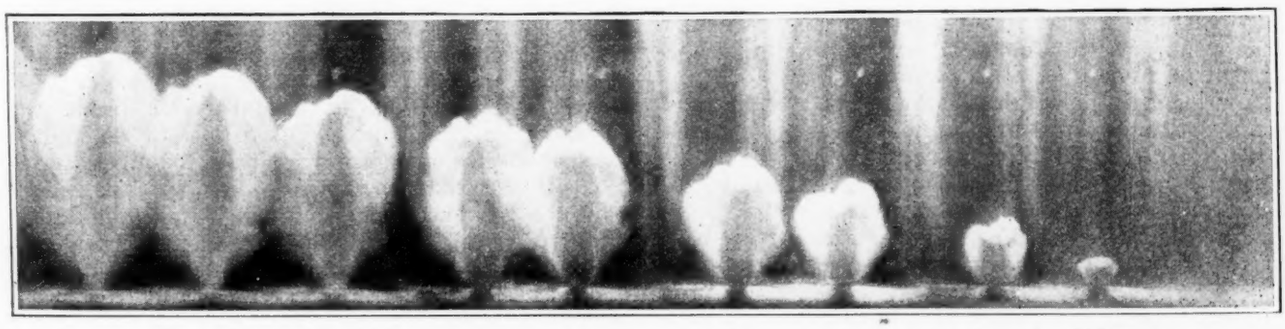


Fig. 5—The high-centrifugal spray shows a different formation when the chamber is under 200-lb. pressure

tain of water. On the sides of the sprays clouds of oil particles appear as bumps, which do not change their position from one picture to another. They show that the oil particles at the outside of the spray are motionless. The included angle for these sprays was increased 50 per cent by injection into dense air.

High-centrifugal sprays injected into the atmosphere and into 200 lb. per sq.in. air pressure are shown in Figs. 4 and 5. The reduction in the spray angle with the spray injected into dense air is about 40 per cent. This may well explain the failure of some centrifugal valves to operate successfully in an engine when the spray appeared well suited for the engine combustion chamber from observations made in the atmosphere. This decrease of spray-cone angle is characteristic of all centrifugal sprays.

The penetration is seen to increase with the specific gravity, and apparently oils of greater specific gravity than those tested would have still greater effects, the highest being fuel oil of 0.9 gravity. From the tests it was found that a heavy oil of 0.90 sp.gr. has 10 per cent greater penetration after 0.003 sec. than an ordinary Diesel oil of a specific gravity of 0.85. The heavy oil is more viscous than the others and is not as readily atomized. This makes the spray angle narrower and helps to produce greater penetration.

It was found that the penetration increases considerably with increase in the angle of the spiral grooves, the 90-deg., or non-centrifugal, spray having 60 per cent greater penetration after 0.003 sec. than the 23-deg. high-centrifugal spray. The spray angle was decreased from 53 deg. to 23 deg. by this same increase in the groove-helix angle.

The effects of varying the ratio of orifice area to groove area from 0.19 to 2.05 upon the spray penetration, cone angle, and the ratio of spray volume to oil volume, with 200 lb. per sq.in. air pressure, were studied. The penetration was found to increase rapidly as the ratio became very small. The ratio was decreased by decreasing the size of the orifice, the groove area being kept constant. Thus the orifice became very small with a small ratio, and the rotation of the jet initiated by the spiral grooves could not continue effectively through this small orifice. The energy which, with a larger orifice, was consumed in rotating the oil, went into giving the spray axial penetration, in the case of the small orifice.

Notes on Carbon Dioxide in the Refrigerating Plant*

By J. C. Goosman

ONE experienced with ammonia refrigerating systems only naturally assumes that the factors controlling the condensation of CO_2 should be identical with those that are now so well understood in the process of liquefying ammonia. Why should there be any difference, it may be asked, when the working medium is carbon dioxide instead of ammonia? Both have to be coaxed into the change from the gaseous condition to the liquid state by means of the well-known team, temperature associated with pressure, or vice versa.

In order to produce liquefaction of ammonia, we are accustomed to determine its temperature of saturation with reference to the temperature of the water as fixed by local conditions—its available quantity and the water pressure necessary for ample circulation—all of which in turn designate a definite pressure of liquefaction. This is all well known and requires no further elucidation.

With carbon dioxide, however, the case is not so simple. We have definite temperatures of saturation with pressures to correspond, yet when applied in the same manner as with ammonia, the temperature of the condensate leaving the condenser is generally found to be considerably higher than the corresponding saturation temperature would lead one to expect. This deviation from the desired condition naturally varies with the condenser type, condensing surface, and the quantity of water employed. It will approach a predetermined temperature most closely with the best condenser type and reach a disappointing figure when the condensing means are less efficient. With ammonia it is at least possible to obtain a condensate temperature but slightly higher than the temperature of the water leaving the condenser when the pressure corresponds. This is not so with carbon dioxide. A pressure corresponding to a certain temperature of saturation never provides a condensate of equal temperature; it approaches the same only at very low condensing temperature when surfaces and water quantities are ample.

The critical temperature—that is, the temperature above which no amount of pressure will produce condensation—for carbon dioxide is about 88 and at this point the liquid condition begins to disappear, attended by a complete loss of latent heat.

Apparently, the use of carbon dioxide at and above this temperature will become non-effective for refrigerating purposes. In practice the apparent loss of latent heat does not at all detract from its value as a refrigerant. In fact, it retains its refrigerating effect nearly undiminished and of practically the same energy, whether below or above the critical temperature, with or entirely without latent heat, at least so far as it pertains to the condensate condition upon leaving the condenser. To illustrate this point it may be stated that the available heat per pound for refrigerating work is 63 B.t.u. at 86 deg. and at 90 deg. it is 59.5 B.t.u. Hence, the refrigerating effect of the medium between 86 deg., which is 2 deg. below the critical, as compared with 90 deg., or 2 deg. above the critical, has been decreased by only 6 per cent.

This emphasizes the importance of the temperature of the condensate for refrigerating efficiency from the power viewpoint more than from that of the refrigerating capacity. Generally speaking, in the region at and above the

*Abstract of paper presented at the Spring Meeting, American Society of Refrigerating Engineers, White Sulphur Springs, W. Va., May 23, 1927.

critical the horsepower per ton increases about 3 per cent for each increase of 1 per cent in the temperature of the condensate for single compression; for dual compression, the power increase per degree increase in the temperature of the condensate averages 2 per cent. These figures are obtained from a Mollier diagram in which an actual working pressure-and-temperature curve has been constructed.

The available condenser types for carbon dioxide equipment are the customary submerged, atmospheric, double-pipe, shell-and-tube and shell-and-coil constructions.

Pipe condensers, it is generally agreed, are an abomination and absurdity. Of these the submerged type is the worst offender. Atmospheric condensers may be tolerated in localities where, with high water temperature and a deficiency in the quantity, a fairly pronounced evaporating effect of the water flowing over the pipes may be obtained.

Subcooling of the liquid, which is so highly desirable, is entirely out of the question with this type. Double-pipe condensers offer the advantages of counterflow and the possibility of liquid cooling when the surface is liberal and the water quantity ample. Very few of these condensers actually installed can be said to possess either of these virtues. The water quantity is often insufficient because of the comparatively high friction head of the 1¼-in. inside water pipe. With water of 80 deg., a range of 5 deg. and condenser work of 300 B.t.u. per min. per ton, a quantity of 7.2 gal. per ton is required. Since these condensers are usually made up in stands of 10 tons refrigerating capacity, it would be necessary to pass 72 gal. per min. through them. This would mean a friction loss of over 50 lb., which, in many cases, is out of the question.

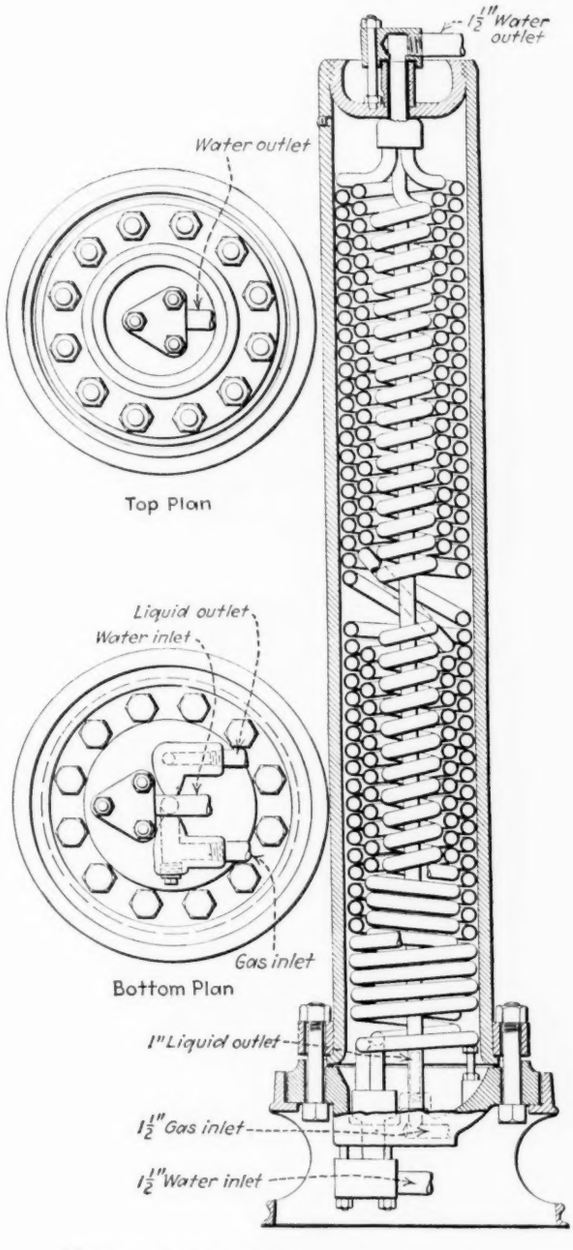
Shell-and-Coil Type Well Known Twenty-five Years Ago

The shell-and-coil type is not new in the refrigerating field. It was well known as long as 25 to 30 years ago as the Hendrix condenser and brine cooler. Referring to this apparatus as a type, it can be stated that no condenser or brine cooler has since been produced that equals it in efficiency.

In general principle the shell-and-coil condenser complies with all the laws governing liquefaction. In the condenser, gas enters the shell at high velocity and turbulent motion. As it strikes the cooling surface of the coils, it condenses into a thin film of rapidly flowing liquid, thereby reducing gas pockets and skin resistance. On its descent to the bottom of the shell it drops from coil to coil, striking colder surfaces as it proceeds until it reaches the bottom, or the coldest place inside of the shell, at a temperature which approaches the initial temperature of the water as closely as the character of the medium and the physical condition within the shell permit.

If allowed to collect at the bottom of the shell and remain for only a short period, it must necessarily decrease in its temperature; at least that is the case with carbon dioxide. Hence there can be no doubt that this type of condenser, when improved to overcome well-known objections, is the most effective apparatus by far for the liquefaction and subcooling of CO_2.

The principle of such a condenser which has been found most effective in CO_2 liquefaction is shown in the illustration. Gas enters through the top of the shell at a temperature of 150 deg. and is diffused into the top part of the shell through numerous small apertures. The gas in this space is therefore in violent motion, circulating over, along and across the cooling surface in rapid currents, eddies and swirling movements. Attention may also be called to the fact that the superheated gas is spread over a large cooling surface; therefore none of the surface is exposed to concentrated heat as in the case of double-pipe condensers, where much of the superheat is absorbed in one or two of the top pipes.



Modern design of shell-and-coil condenser

As soon as condensation occurs, the surface in that part of the condenser is covered with a rapidly moving film of moisture, which forms drops or globules and thus drops from pipe to pipe until it reaches the bottom, to be further subcooled. The coils are of equal lineal length, of the same pipe diameter and therefore of equal friction head. This is accomplished by exchanging the coil diameters at mid-height between the inside and the outside coil.

Operating Duplex Pumps

By Roland L. Tullis

Occasionally, the selection of the right type of pump for a certain service is quite a problem. A few years ago I took charge of a hospital plant that had been using duplex steam pumps for the circulation of hot water. We received quite a few complaints about throbbing or pulsations in the water lines. If the hot-water pipes happened to be a little loose in their straps or brackets, they would vibrate and make a slight noise. As hospital patients are supersensitive to noise of any kind, I decided to move the duplex pumps from the hot-water circulation service and place them in some service where silence was not so essential. They were replaced by motor-driven centrifugal pumps, which have been in operation for a number of years without a single complaint. They have proved more economical to operate with less trouble and maintenance expense.

At another time we had some trouble with the boiler-feed water pumps. One of the firemen came running to the chief and excitedly explained that the water was getting low in the boilers and that the feed pump would not work. Such incidents are amusing to the experienced engineer or at least nothing to get excited over. He grinned and said to the fireman, "Come along and I'll show you how to get it started."

He walked over to the offending pump and opened the throttle slightly, but the pistons would move with a jerky and erratic motion and it refused to pump. He glanced at the water level in the feed-water heater and found it correct. Next, he opened the pet-cock on top of the pump valve chamber and dry steam escaped from the cock, indicating that the pump was steambound. Next, he climbed on top of the boiler and closed the stop valve on the feed-water line where it entered the boiler. Then he opened a relief valve on the same line between the pump and the stop valve. This allowed the steam in the line to escape. Next he told the fireman to start the feed pump again. When this was done, the pump picked up its suction and worked properly, water issuing from the relief valve that the chief had opened. He now closed the relief valve and opened the valve to the boiler; the pump began to deliver water, and the water level was soon back to normal.

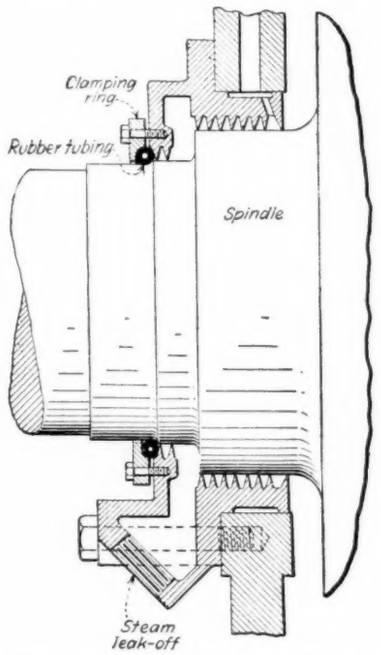
Later, he explained to the fireman: "The trouble was caused by a leaky check valve on the boiler feed line on top of the boiler. During the noon hour there was a low steam demand and you had shut the pump down; high-pressure steam leaked through the check into the feed line and pump chambers, causing the latter to become steambound. Sometimes it is difficult to get a pump started under such conditions. That is why I put that relief valve on the feed line. That trouble has occurred before and I was prepared for it. When we get a chance we'll have to put in a new check valve."

It always pays to use the very best check-valves on a boiler feed line as they are working under severe conditions. When the feed-pump is running slowly, they must open and close with practically each stroke of the plungers. In this service I have seen light and cheaply constructed check valves literally pound to pieces in a few months.

I recently visited a producing field of one of the largest oil companies, where a friend was employed. I was interested to see the great number of duplex steam pumps in service. There were literally hundreds of them scattered about everywhere; some of them a great distance from the nearest boiler. Undoubtedly, they are selected on account of their dependability. Steam economy is of secondary importance, as the boilers are fired with oil or natural gas produced in the field.

Soapsuds Method of Finding Air Leaks into Surface Condensers

In an article on the "Elimination of Air Leakage in Surface Type Condensers" in the May number of *The Au Sable News*, a publication of the Consumers Power Co., J. W. Mackenzie gives the following method of testing condensers and turbines for air leakage. The method is applicable to both large and small units and



Sealing turbine shaft for leakage test

serves to determine sources of air leakage in all parts of the equipment. It consists of admitting air under a pressure of 2 or 3 lb. into the turbine, condenser and all piping that is to be tested. To seal around the turbine shaft so that this pressure may be maintained, a suitably sized rubber tube with heavy walls is clamped around the shaft as shown in the illustration, thus effectively sealing the space between the turbine shaft and labyrinth packing. In cases where the atmospheric relief valve is not of the spring-loaded type, it also will be necessary to put a head of water on the valve.

When the known leaks are sealed, all surfaces are painted over rapidly with heavy soapsuds applied with a large whitewash brush. Wherever air is leaking out, a small soap bubble will form and the leak can be marked and corrected after the test is completed. By this method even the smallest leaks can be detected.

The cut is shown merely to give a general idea as to the method of sealing around the turbine shaft. Each turbine will present an individual problem on account of the variety of types and sizes of sealing glands. The rubber tubing and clamping rings in two or more parts should be provided for each turbine. Arrangements for clamping the tube and ring in place may be by screws as shown, by wedges or by other means.

EDITORIALS

F. R. LOW, *Editor*

A Unique Boiler Repair

THE story of the erecting engineer, who, finding it necessary to bend a piece of pipe into the form of a coil, heated the pipe and wrapped it around a telephone pole outside of the plant before he discovered that the coil could not be removed from the pole, finds its parallel in the report of a boiler inspector of a Midwestern state on a repair job attempted upon a return-tubular boiler. His story illustrates a case where a little thinking before doing would have been valuable.

The lower shell of the boiler had been overheated and was badly bagged. The man in charge of the plant did not believe that the bag could be driven back, so he devised a method of his own to make the repair. First, he removed the dome from the top of the boiler and had a plate riveted over the opening in the shell. Next, he proceeded to turn the shell over so that the patch over the dome opening would fall at the bottom. His plan was to rivet the dome over the bag in the shell so as to relieve the overheated metal of the full pressure of the boiler. Finally, he foresaw difficulties in his way and called in the inspector to point out where he had gone wrong.

This case furnished additional proof that only competent men should be permitted to care for and operate pressure boilers.

A Commendable Project

AT THE annual meeting of the Society for the Promotion of Engineering Education, held at the University of Maine during the latter part of June, a resolution was passed looking forward to the setting up of a permanent agency for the study, investigation and co-ordination of all factors pertaining to our system of engineering education. The fulfillment of such a hope expressed in the resolution will be a decided step forward and one in keeping with the progress of engineering education in this country.

The setting up on a permanent basis of such a central agency does not mean the creation of an entirely new and untried activity in the affairs of the Society, but the continuance of the excellent work which has been going on during the last four years under the special Board of Investigation and Co-ordination. The findings and accomplishments of this Board under the direction of W. E. Wickenden and his associate, H. P. Hammond, fully justify putting the work on a permanent basis. It is to be hoped that the financial support necessary for this project will be forthcoming so that no interruption in the carrying out of the plan will be necessary.

One of the noteworthy developments resulting from the investigation of the Board is the establishment of two summer schools for engineering teachers, one to be held at Cornell University, and the other at the University of Wisconsin. This action on the part of the Board is an attempt to realize its conviction that our engineering schools need better teaching methods and better qualified teachers. This move should have the unqualified support of engineering educators and all those interested in engineering education.

The work which has been done by this Society during the last four years is rather unique, for it represents one of the first attempts of a group of professional educators to study, investigate and co-ordinate their own activities. It is an excellent piece of research and investigation and typifies an attitude which both education and industry can well profit by.

The Vertical Condenser

VERTICAL condensers have been installed in many plants where the river level fluctuates between wide limits. As a consequence it was necessary to place the condenser in a pit in order to provide a satisfactory siphon loop for the circulating water at low river levels.

Vertical condensers have been and are being installed in new plants that have constant water levels in the adjoining rivers and lakes. It is of interest to analyze the reasons for the choice of the vertical type in such plants and to inquire if there is a trend toward its wider adoption.

Turbines of large size characterize most of the latter group of stations using vertical condensers. In order to provide sufficient exhaust area and at the same time sufficient condensing surface, the exhaust is split and is carried to two vertical condensers placed one on each side of the main unit. This arrangement permits more rigid and substantial foundations under the large low-pressure turbine, which is desirable. The condenser tubes can be drawn vertically, and this will admit of a turbine room of smaller floor area than where horizontal clearances must be provided to draw tubes. Furthermore, it may be possible to save some turbine room height, for foundations will not be so high when the condenser need not be built under the turbine.

The vertical condenser introduces some new problems. Will the condensate be greatly undercooled in this design? Also what effect, if any, does condensate running down the tubes have on the heat transfer rate? Should water flow up through the tubes or down through them? In the latter case care must be taken that the velocity downward due to gravity does not cause cavitation in the tubes. Possibly smaller tubes can be used with downward flow and thus secure higher heat transfer.

The use of vertical condensers has been largely confined to large plants with turbines of unusual size. Their wide adoption in the average plant does not seem imminent. However, it will be interesting to study their performance in the new stations and to avail ourselves of all the advantages that may be proved for this type of condenser.

Bearings Are Still a Subject of Controversy

WITHIN the last few years anti-friction bearings have come into very general use where sleeve bearings were previously used, and the possibilities of extending their application are probably a long way from being exhausted. In some applications the anti-friction bearings have a decided advantage over the sleeve type with regard to friction, power reductions as high as 60 per cent or more being reported. In all applications they have the advantage of low starting friction. This may or may not be of particular consequence.

On applications where the break-away load is two or three times the running load, friction may be of considerable consequence. If the starting torque is the limiting factor in the selection of a motor, anything that can be done to reduce the load at starting will simplify the motor application. This may not only reduce the cost of the motor and control equipment, but allow the use of a more desirable type of motor. The starting torque of synchronous motors in general is less than that of other types. On loads requiring high starting torque this class of motor is generally at a disadvantage, unless a clutch is used between the motor and load. In many applications a large part of the load at starting is friction of the bearings, particularly in cold weather. Anti-friction bearings may make possible reducing the starting load to a value where the synchronous machine, with its better power-factor characteristics, can be used.

So far as running friction of motor bearings is concerned, there is practically no difference between the two types. With the older type of sleeve bearings there was a greater tendency for the oil to get out of the bearings and on the windings, than with the anti-friction types. This difficulty has been overcome in the well designed modern sleeve bearing. Both types of bearings of modern design require lubricating only at long periods, and probably both have records of equally long life. These and other facts have caused some operating men to question the advisability of the present tendency to a general use of anti-friction bearings, especially on motors where the only gain, if any, is in mechanical details.

It is argued that, so far as efficiency and the lubrication of the motor and the life of the bearings are concerned, there is probably little choice between the two types, except perhaps where the bearings are subjected to vibration. In this case if a flexible coupling be used, the sleeve bearing will stand up as well as the anti-friction. When the maintenance of the bearings is considered, the advantages appear to be on the side of the sleeve type.

It is pointed out that almost any mechanic can repair a sleeve bearing when it becomes worn, whereas the anti-friction type requires a complete replacement. If spare bearings are kept in stock, the sleeve type requires practically no attention, while the anti-friction must be carefully stored in grease to prevent pitting. If spare parts are not stocked and a bearing fails, the sleeve bearing can be repaired in the handiest machine shop, where a new anti-friction bearing may have to be obtained from the manufacturers, with consequent delays in getting the machine back into service.

Both classes of bearings have advocates, who insist upon having their particular type, but the majority of users are interested in obtaining a bearing that will give the least trouble and the lowest maintenance costs, and this involves a careful consideration of each class of application.

Combustion Control

THE application of automatic combustion-control equipment to power plants is increasing. The small and medium-sized plants were the first to apply this control and the equipment usually consisted of a master steam-pressure regulator, controlling the positions of dampers, rheostats or engine valves connected through cables, levers and shafting. Later, as forced-draft installations increased, furnace pressure regulators were added to keep the draft in the combustion chamber within bounds.

Within the last two or three years large central-station engineers have realized more fully the value of control systems, but they have tried to keep away from the old methods of tieing controls together through lineshafting and cables and have insisted upon more flexible and more accurate methods for controlling the quantities of fuel and air over the entire range of boiler load. This has necessitated the installation of individual regulators to control the operation of each boiler. These regulators are not tied together mechanically, but through loading devices that leave the individual regulator free to take care of irregularities in the furnace to which it is connected. One master regulator controls through its loading device the setting of all the individual regulators. The individual furnace regulators may be loaded to hold certain characteristics peculiar to their own furnace in addition to the master regulator loading. They are also provided with manual control stations so they can be adjusted or operated manually, should it be found desirable.

Engineers differ in opinion as to the gain in efficiency and the reduction in operating force that can be credited to automatic control, but they all realize that when the responsibility for correct operation of all the boilers is placed under this unit system of control, the human element is greatly reduced. This alone might warrant the installation of such equipment, even if the other advantages such as increased efficiency, reduced labor cost, reduced maintenance and outage and general smoothness of plant performance were not realized. Any equipment that will reduce the danger of plant shutdown and outage is an important item in plant design.

The art has advanced to the point where there is appropriate equipment available for any needs. The engineer who omits combustion control from his plant must justify his decision on the ground of an exceptionally high standard of manual control.

Famous Engineering Museum at Munich

CONSIDERABLE interest attaches to the engineering museum at Munich, Germany, because of three projects of a similar nature in this country for Washington, New York and Chicago. The widespread building of this famous German museum houses not only models, but full-sized operating equipment pertaining to all the major branches of engineering. It is not so much a repository of historic relics as an active constructive and educational force in German industrial and engineering life.

That a similar museum in this country would exert the same sort of educational influence in the engineering field seems certain, and it is believed such an institution would soon take its place as an educator of the first magnitude.

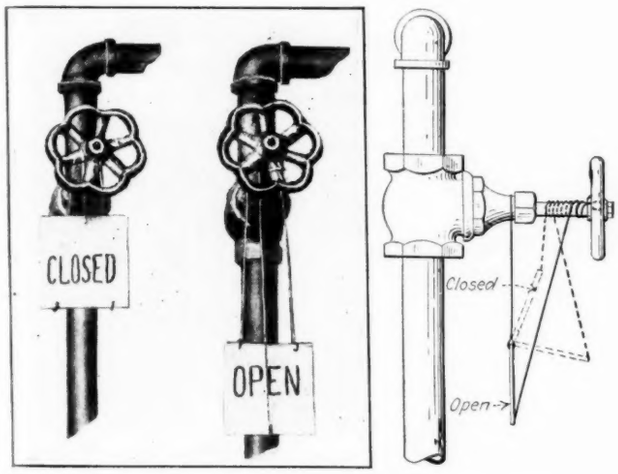
IDEAS *from* PRACTICAL MEN

Readers are urged to use this department for the exchange of practical operating information. A minimum of five dollars will be paid for contributions accepted

Open and Closed Valve Sign

From a distance it is hard to tell whether a valve is open or closed. We had one that could be reached only by walking around another pipe line, and it caused many "cuss" words at times. One of the men put a stop to this by rigging up a little sign device which, though roughly made, answered the purpose.

Procuring a square piece of flat steel, he painted the words "Open" and "Closed" on opposite sides and drilled two small holes in one end and one in the center at the other end. Fastening a piece of stout cord in the two holes, he looped it a couple of times around the bonnet. A single cord fastened to the other end was wound around the stem and finally secured to one of the arms of the wheel. The illustrations show the device in the opened and closed position. As the valve wheel is turned



Open and closed sign is operated by a cord wound around valve stem

open, it unwinds the cord and lowers the plate to expose the open sign. Vive versa, of course, it raises the plate to the closed position. It is not an elaborate device, but it never fails to work. ARTHUR KENDALL.

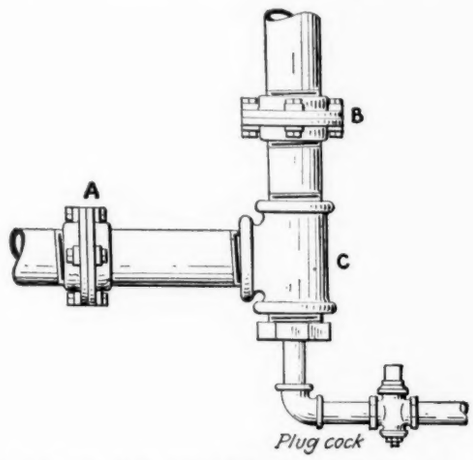
Hamilton, Ontario, Canada.

Reducing Steam Consumption for Heating Purposes

In a factory where numerous glue-heaters were in use, the engineer was continually bothered by some of the workmen who seemed never to be satisfied unless the half-inch supply valve was wide open all the time and steam blowing to waste. Accordingly, the engineer watched his chance and cut the supply pipe and put in a bolted union, with a thin metal disk, having a small hole in it. This hole passed all the steam needed by each kettle and considerable steam was saved.

After a few months steam was found to be blowing through the kettles again. Investigation showed that the hole in the metal disk had been greatly enlarged by water in the steam. The union and disk had been installed in a horizontal pipe, as at *A* in the figure, hence the cutting of the disk was at the bottom of the hole.

The union and disk were removed and placed in a vertical pipe, as at *B*, and a tee was put into the line,



How metal disk was installed in the steam line

as at *C*. A piece of one-inch pipe and a reducer were screwed into the lower opening of the tee, and a plug cock was placed to act as a blowoff when the pipe was to be cleaned of dirt which might collect, and there was no further cutting of the disk. JAMES F. HOBART.

Indianapolis, Ind.

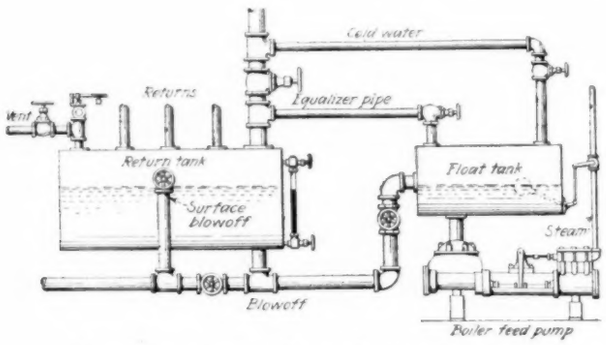
An Arrangement for Removing Cylinder Oil from Condensation Returns

It was a matter of economy in one plant where I was employed to use the exhaust steam from the engine with several processes in the factory and to use the returns for boiler feeding. But the oil from the returns got into the boilers, so some means had to be found to overcome this trouble. This was done in the following manner:

The returns were brought back to a return tank, which was fitted with a gage glass, so that the water level would be indicated at all times, and a surface blowoff connection, as shown by the illustration. At the bottom of the return tank a connection was made to the float tank, at about the center of the end head. The connection to the pump was made as direct as possible so that the water would flow from the float tank to the pump by gravity. A float in the supply tank operated the throttle valve of the pump.

From the return tank a cold-water feed line and also an equalizing line were run to the float tank, as shown.

All pipe connections were properly valved, and the return tank was provided with a relief valve. With this arrangement the condensation in the various lines in the factory comes to the return tank, where the oil rises to the top of the water. The water finds its level in the float tank through the large bottom connection, and what little oil passes to this tank rises to the surface. The pump receives its water supply from the bottom of the



Arrangement of tanks and connections for removing oil from returns

tank, and so there is but slight chance of oil getting to the pump and then into the boilers.

Both tanks can be blown off at the surface of the water through the two pipes, as indicated. Since this arrangement has been in operation, the trouble with oil in the boilers has disappeared. A. J. YANCY.

Louisville, Ky.

Double-Motor Drive Replaces Single Motor

A large planer was driven by a 15-hp. motor that was belted through a countershaft. When the planer was working at its full capacity, the motor seemed to be doing its limit, as, when taking wide cuts, up to nearly the full width of the machine, the motor slowed down noticeably. One day it failed and was sent away for repairs. No other motor of similar power was available, and it was decided to connect two 5-hp. motors direct to the pulley on the cutter-head shaft. Accordingly, after some speed figuring had been done, pulleys were selected and placed on the two motor shafts, of such diameters as was supposed would drive the planer at the required speed.

Before turning the machine over to its operator, tests were made to determine if each motor was actually driving the cutter heads at the same speed. Several boards of the same width and kind of wood were surfaced lightly to reduce all to the same thickness. Then one motor only was switched on, the other being allowed to run idle, but its belt was not removed.

The single motor was able to drive the machine up to speed while the narrow test boards were run through the machine, taking such a cut as the power would carry without slowing down. No tachometer being at hand, an ordinary revolution counter was used and the speed of the cutter-head determined while running idle and also while a cut was being taken off the test boards.

The speeds were recorded, then the driving motor was cut off and the other one switched on. Similar speed tests were made and recorded. Upon comparing the speeds, it was found that each motor drove the planer at about the same speed while no work was being done, but when a cut was being taken, one of them drove the cutter-head about 100 r.p.m. faster than the other.

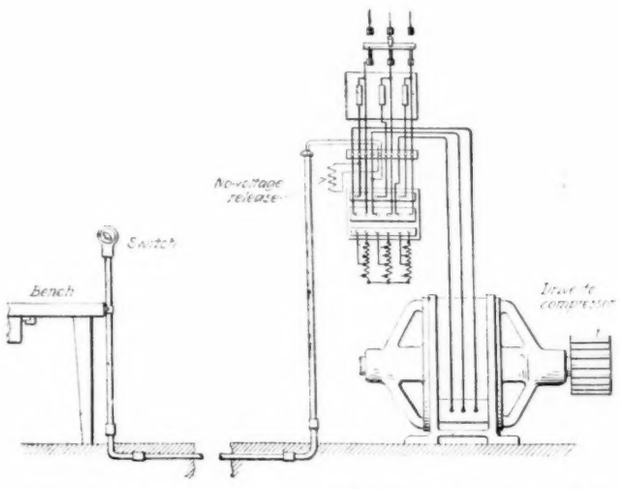
The motor pulleys were changed slightly so as to obtain the same working speed from each motor. It was not thought desirable to turn down one of the pulleys, therefore one of them was built up by winding upon it a strip of ordinary cotton duck of the 8-ounce variety. To hold the cloth in place, common rosin was melted and enough machine oil stirred in to make, when cold, a sticky and tenacious substance, some of which was daubed on one side of the cloth strip and on the pulley as the strip was wound on by hand under the belt. The cloth lagging was wound on or removed until each motor gave the same working speed to the cutter-head.

It was found that the two 5-hp. motors directly belted gave more power than the 15-hp. motor did driving through a countershaft, so they were used permanently to drive the machine. The cloth lagging, after a year of service, was apparently in as good condition as when first applied. JAMES F. HOBART.

Indianapolis, Ind.

Remote Control for Air Compressor

When we installed a large motor-driven air compressor a short time ago, it was thought advisable to make provision for stopping the motor from a point in the repair shop about 100 ft. from the starter. This was done as shown in the illustration. One wire of the connection or leads to the no-voltage release coil in the starter was opened, and the circuit was extended through a line of conduit which had been previously used for a lighting circuit, to a point in the shop where most of the repair work was done. An ordinary snap switch was used to



Arrangement of remote control for compressor motor

close the circuit. With this switch located in the shop, the compressor could be stopped at any time by simply turning the switch to the open position and without the necessity of going near the starter.

Although this is a comparatively simple application of the remote-control idea, there are undoubtedly many places around a plant where it could be extended to include several points and prove a real advantage, particularly on coal conveyors and other similar equipment where there is possibility of trouble or accident.

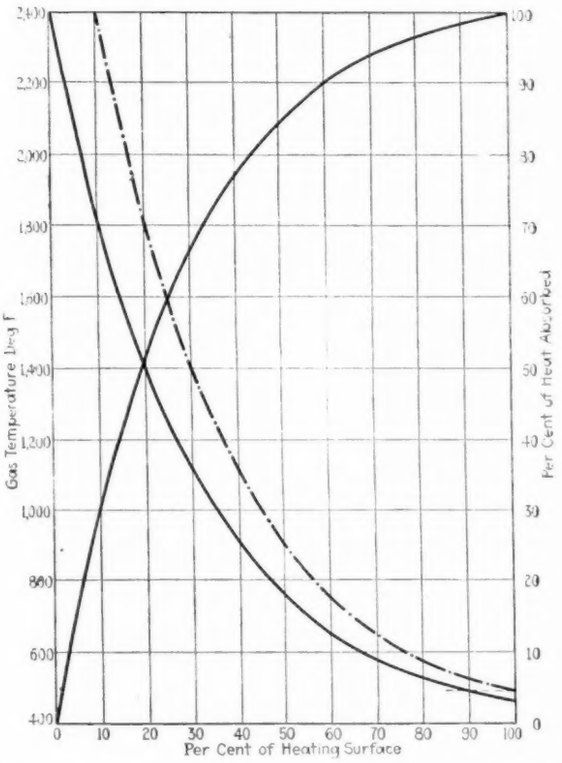
Pittsburgh, Pa. S. G. JOHNSON.

COMMENTS *from* READERS

The Valuable Part of a Boiler

Recently, the chief in a certain power plant got the idea that he could improve his plant efficiency by raising his boilers several feet. The equipment, all in fair shape, consisted of several bent-tube boilers, undeniably set too low, a metal breeching running along the backs of the settings and connecting to an ample stack through an opening at the breeching level.

As outlined by the engineer, the plans were to leave the breeching in its present position, raise the boilers one at a time, and connect them to the smoke duct by an opening which would be lower down in the back pass by just the amount that the drums were elevated.



Graph showing gas temperature and percentage of heat absorption at various points along the tube

A salesman happened to call on the chief while the plans were being considered, and although he supported him in the details of increased combustion space, rear arch over the stoker, etc., he ventured the criticism that the proposed arrangement would cut nearly 5 ft. off the active heating surface of the rear tube banks. To this the chief replied: "I know it, but the back bank isn't much good anyhow; gas temperature isn't much over 500 deg. I don't think the small heat transfer will pay for raising the breeching and cutting a new hole in the stack. If it was 5 ft. off the front bank, it would be a different story and the flue-gas temperature would run pretty high."

Right here the salesman did a lot of thinking, and it is worth a little thought to determine the relative effect of cutting out 10 per cent of a boiler surface from the hot end and the cool end. It is generally accepted that in a bent-tube boiler the first bank does 70 per cent of the work, the second bank 25 and the rear bank only 5 per cent. This would seem to settle it at once that a sacrifice of 10 per cent could be made in the rear bank with little effect on the flue gas and that a similar elimination in the front bank would be disastrous. Looking at it another way, however, it is not so clear.

For simplicity let us imagine a boiler consisting of one water tube 100 ft. long and of such a diameter that each running foot has one square foot of heating surface. At one end we will supply 600 lb. of furnace gas at 2,400 deg. F. This gas passes the entire length of the tube, escaping to the stack at the far end. We will assume that the heat transfer is 5 B.t.u. per hour per square foot per degree difference in temperature and that this transfer rate is constant, which will be nearly true if there is no absorption of radiant heat. We will take the temperature inside our tube as 400 deg. and the specific heat of furnace gas as 0.25.

Before it hits the tube, the total heat in the gas will be $2,400 \times 600 \times 0.25 = 360,000$ B.t.u. per hour. For the first foot the temperature difference will be $2,400 - 400 = 2,000$ deg. and the absorption is $2,000 \times 5 = 10,000$ B.t.u. per hour, which leaves the difference, or 350,000 B.t.u., still in the gas. Knowing the weight and specific heat we find the gas temperature to be $350,000 \div (600 \times 0.25) = 2,335$ deg. In just the same way we can compute for the entire length of the tube, the results being more accurate if we take small steps. The table gives results for various points.

HEAT ABSORPTION AND GAS TEMPERATURES AT VARIOUS POINTS ALONG THE TUBE

Distance Along The Tube, Ft.	Heat Absorbed by the Tube, B.t.u.	Gas Temperature, Deg. F.
0	0	2,400
10	86,250	1,825
20	147,600	1,416
30	191,550	1,123
40	222,750	915
50	244,950	767
60	260,700	662
79	272,100	586
80	280,050	533
90	285,750	495
100	289,950	467

This is shown in the graph, which indicates clearly that cutting out the last 10 per cent of the imaginary boiler raises the flue-gas temperature only 28 deg. and cuts down the heat absorption only 1.5 per cent. The first 10 ft. is seen to do nearly 30 per cent of the total work, but the point often overlooked is that if the first 10 sq.ft. is eliminated the second 10 ft. becomes, for all practical purposes, the first 10 ft. and so on throughout the boiler, as shown by the dot-and-dash lines on the graph. The net result is found to be the same, and the conclusion is that the last 10 per cent of a boiler is just as important as the first 10 per cent.

If a large part of the heat transfer is by radiant heat, the condition is modified, but in elevating a boiler it is not usual that the radiant-heat absorption is disturbed.

Oak Park, Ill. ELMER S. SMAIL.

Transatlantic Flights

Whatever I may miss reading in *Power*, it is not the Foreword by F. R. Low, because of its interest and instructiveness. But this week I regret to find that he has made the same mistake that has been made by so many writers recently—in his case unwittingly, I am sure.

When referring to Lindbergh's wonderful flight from New York to Paris and Chamberlin's record-making flight to Germany, he writes: "Two planes have now made the Atlantic flight without a stop." A slip of course, because we all remember that some time in 1919 Alcock and Brown made the first non-stop flight across the Atlantic and aviation has made a few strides since then. I want to remind the readers of *Power* of the first and almost successful attempt to fly across the Atlantic. This was made by Hawkins who, with his plane, fell into the ocean somewhere to the north of Ireland.

Considering that he was the first, and that his equipment was not modern, it must be conceded that Hawkins was not less daring than his more successful followers. "Nothing succeeds like success," still Hawkins deserves to be remembered. I hope that Lindbergh and Chamberlin will not in eight years be so utterly forgotten as Alcock, Brown and Hawkins appear to be.

Long Beach, Calif. E. J. JORDAN.

An Engineer Prefers the Atmospheric Condenser

In the smaller refrigerating plants where city water is run over the condensers and the waste run to the sewer, or where water is a factor due to pumping or scarcity, I have found no type of condenser that will compete with the original atmospheric top-supply of 24 pipes per stand, when less than one gallon per minute per ton of machine capacity is considered. The 24- to 36-pipe stands take much advantage of the cooling and evaporating effect of the air on this or a less quantity of water.

It is claimed that a condenser more than 12 pipes high is useless. This, no doubt, is true where 3 to 5 gal. per min. per ton is passed over them, but this does not mean that a 12-pipe unit will compete with a 24-pipe one with a flow of one gallon or less.

I am submitting test data taken from a high condenser to show the relative amount of heat absorbed by the condensing water compared to the cooling and evaporating effect of the atmosphere.

Heat taken per hour, B.t.u.	96,000
Heat imparted to water 1,687 lb. raised 20 deg.	33,740
Heat expended due to evaporation B.t.u.	62,260

In this test the head pressure was 185 lb. gage and the back pressure 20 lb. gage. The water went on condensers at 70 deg., flowed off at 90 deg.

The temperature of the water as it passed down over the pipes was:

Pipe	Water, Deg. F.	Pipe	Water, Deg. F
Top	70	7	89
2	75	9	90
3	79	10	90
4	83	11	90
5	86	24	90
6	88		

It will be seen that after the seventh pipe the water remained at 90 deg. over the remaining 17 pipes. This test showed that more heat was being taken up by the lower 17 pipes than the seven upper, which were getting the coldest water. This was due to evaporation.

This condenser could be improved by adding a short double-pipe coil to the exit end so that water would pass through it first, getting a maximum water temperature before going onto the top pipe. A better gas velocity would be maintained, the water temperature off would not be so high, and a correspondingly lower head pressure would be obtained. M. H. MILLS.

St. Louis, Mo.

What Would You Do?

The story "What Would You Do?" which appeared in the June 28 issue, is by no means an unusual one. Answering the engineer who faces the loss of his job if the plan of purchasing current and low-pressure steam is followed, I would say that there may be a way out of his difficulty, depending on how ingenious he is. Instead of buying exhaust steam from his neighbor's modern plant, why not buy high-pressure steam and run his engine at partial capacity to supply the process steam demand, shutting down boilers that are out of date and in bad condition? If his neighbor can supply steam at 200 lb. pressure and superheated 100 deg. and his old boilers can carry only 100 lb. pressure, his engines will be far more efficient than formerly; but these two conditions are only assumed, as no details are available on this point. He has not told us how much exhaust he can use in winter months. If his plant is in the North the quantity will be great enough to be a serious factor, but for all we know he may be in Florida or California, where no steam heat is needed.

If his engines are old, the question of fixed charges can be ignored and a solution based on assumed conditions can be worked out. If he requires 10,000 lb. of process steam per hour for 50 hours a week and exhaust steam can be bought for 25 cents per thousand pounds, and if he requires 300 kw. which can be bought for 1.75c. per kw.-hr., the total cost of steam and electricity is $387.50 per week. If he can purchase high-pressure steam the electrical energy can be developed as byproduct power if his generating units can attain a rate of 34 lb. per kw.-hr. Assuming that the high-pressure steam costs him 60c. per thousand pounds, the weekly cost of generating current and buying high-pressure steam is $300 weekly, not counting the engineer's wages and the upkeep of the engines. It is obvious that for successful operation of this plan his salary plus engine upkeep costs cannot exceed $87.50 per week, and it is equally obvious that he cannot afford to pay more than 60c. per thousand pounds for steam.

We accept, of course, his statement that a new plant to compete with purchased current and steam is not practical, but why not consider a deviation from this plan? In a near-by city a power company conceived the idea of selling low-pressure steam and electricity to manufacturers, but not enough customers could be secured to warrant the expense of a long pipe line, and it was clearly shown that most of the private plants could generate at least a part of their current far lower than they could buy it, even though their plants were not modern.

An engine builder has already demonstrated the practicability of removing old slide-valve cylinders and substituting uniflow cylinders suitable for high pressure and temperature. This would improve the steam rate of an engine to a remarkable degree. Instead of installing a complete new boiler plant, one new unit or even a second-hand unit suitable for high pressure could be installed, and the demand for process steam would govern the

amount of current generated. The objection that the engines are not designed for over 100 lb. pressure and that they are not worth revamping can be overcome, as I once worked in a plant that installed a 200-lb. boiler but retained the old engine. It was not safe to increase the initial pressure on the old units beyond 100 lb. Studies made in that case showed that a small unit could be added to the plant to function as the high-pressure cylinder exhausting to the old engine. A 25 per cent decrease in steam consumption was proved possible, but the plan was not executed as the mill was on a three-day a week schedule.

The greatest disadvantage is that this engineer cannot claim credit for the $9,000 to $10,000 annual saving that the firm will make by scrapping the old plant, as the ideas have not come from him, but from the central station and neighboring plant. Had he taken the initiative five years ago and written asking how to cut his costs at a moderate outlay for plant improvement, very likely he would today be master of the situation.

Springfield, Mass. A. F. SHEEHAN.

Why The Globe Valve Failed

Referring to R. Manly Orr's discussion in the June 21 issue on an unusual failure of a throttle valve, I have had the same experience with a globe valve on a new 4-in. line, 200 ft. long and carrying steam at 100-lb. pressure. The valve was ahead of a reducing valve leading to the heating system, and it was the watchman's duty to turn on steam early in the morning. The yoke of the valve broke twice before we got around to have the pipe covered and the drips properly drained, since which it has given no trouble for three years.

When Mr. Orr spun the valve shut with considerable speed, it stopped all steam leaks, water accumulated above the throttle valve and evidently got surging in the line.

New York City. THOMAS SHEEHAN.

Retarding Corrosion in Boiler Drums by Use of Protective Coatings

The item on page 955 of the June 21 issue, relative to protective coatings in boiler drums, reminds me of some of my experiences along the same lines.

Some years ago I had charge of a small power plant in Brooklyn in which there were two 2,500-sq.ft. water-tube boilers. As only one boiler was required at a time, the other one was cut out for cleaning and overhauling—thus each was in service one month at a time and out for cleaning one month.

Upon examining the inside of the steam drums, we found that corrosion and pitting had started along the water line on each side of each drum in both boilers. The area so affected was about 7 in. wide and extended the entire length of the drums, which was 12 ft. The pits were small—pin points—and had sharp edges. When first noticed, they were about $\frac{1}{32}$ in. deep. The feed was city water fed by an injector, and the steam pressure carried was 100 lb. gage.

In order to prevent further corrosion and pitting, we conceived the idea of painting the parts so affected with a good stiff paint made of red lead and boiled linseed oil. Of course the surfaces were scraped, brushed and thoroughly cleaned before applying the paint. The paint was well brushed into the pitted surface and permitted to dry for several days before filling the boiler with water and raising steam to cut into service again.

After the boiler had run for one month as usual, it was cut out and opened for examination. The paint was still on the surfaces although it had changed from a bright red to a dull brownish red like burnt brick so to speak. Again a man was sent in the drums to scrape and clean the surfaces and apply another coat of the red lead paint. This was done for three consecutive months in each boiler, and later examinations showed that the corrosion and pitting had ceased. I was in that station for ten years and never had any further trouble of this kind.

The red lead filled the pit cavities and baked hard in them and never showed any disposition to come out. Once in a long while we would apply a coat of the red lead paint merely to make sure of protection.

Brooklyn, N. Y. C. J. MASON.

"We Say We Do It in the Union Plant, and Do," says Nixon

Under the section of "Comments from Readers" in the June 28 issue of *Power*, it is noted that Henry James takes issue with the facts on the Union Plant of the Hercules Powder Co., published in the May 10 issue. Mr. James lays most of his stress upon whether or not the reported boiler efficiency of 77 per cent was being attained actually.

We believe that this figure is as accurate as any reported efficiency figure, but realize that all such figures are subject to more or less error. Nevertheless, we attempt continually to check all the factors making up this calculation, to the end that it may be determined as accurately as possible. Our meters are checked regularly, and a careful survey of the coal stock is made at regular intervals. We have had special tests run by Rutger's University men. We feel, therefore, that our figures are reasonably correct.

However, the attainment of high boiler efficiency is not our sole aim. This is only one of the factors and not the most important entering into our purpose to maintain actual low cost power as applied to the unit cost of our products.

We have no men in our local organization who feel that they are power experts. In fact, we have no special power department. We have some good average men who understand and can apply the essentials of economical power generation, but most important, we have a general organization who realize the important relation that power bears to our costs and the important relations that the methods of operations may have toward the efficiency of power generation.

These things, coupled with an excellent coal for our purpose and ideal water, give a situation that will produce good results. When attained, it will be with a realization that the whole organization has played its part and contributed its bit to the accomplishment. The result so obtained by any group of average men will far outweigh usually the result obtained when working only from the viewpoint of power generation. Our control of the load factor places us in an advantageous position with respect to central station practice where they have a minimum control of the demand and must stand by with banked boilers and excess equipment ready for the peaks. A. B. NIXON, Superintendent,

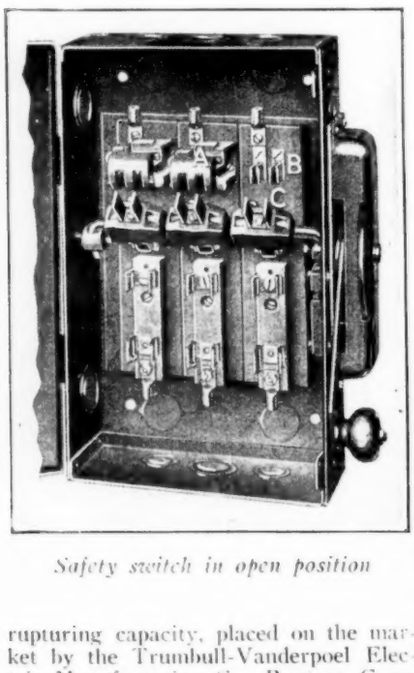
Union Plant, Hercules Powder Company.

Parlin, N. J.

New and Improved EQUIPMENT

Double-Break Type Safety Switch

Safety-switch development has been one of the most active in the electrical equipment industry, and each year brings forth a number of improvements. One of the latest developments is a switch with a double break and an arc blanket device to increase the current



Safety switch in open position

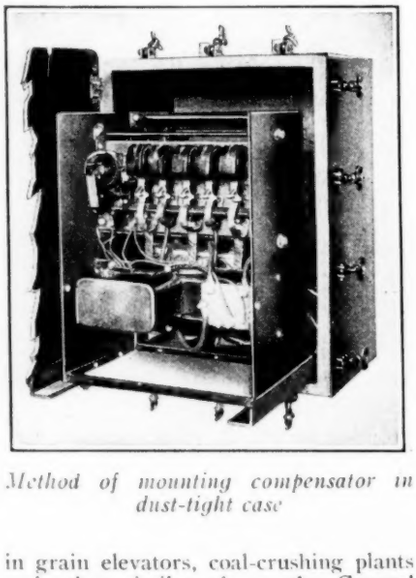
rupturing capacity, placed on the market by the Trumbull-Vanderpoel Electric Manufacturing Co., Bantam, Conn. As shown in the figure, the blades *C* of the switch are U-shaped and close into two adjacent clips *B*. These clips are surrounded and separated by an arc blanket as shown at *A*.

The object in the design of the switch is to prevent the formation of an arc rather than to quench it after it forms. Since the circuit is broken at two points on each pole of the switch, the voltage rise to maintain the arc is only one-half that for a single break. For instance, on a 220-volt circuit the voltage rise at the point of interruption is only about 110 for the double break instead of 220 for the single break. The contact points are inclosed in an arc blanket, in which the air content is so small that the combustion of the metal by the arc is negligible. This feature prevents arc formation, by reducing the amount of conducting gases formed at the points where the circuit is broken. There is also a certain cooling effect on the arc by the blanket, which tends to reduce its intensity.

As a result of the improvement in the circuit-rupturing feature of the switch it has been possible to reduce its dimensions for a given capacity over those for older designs by about one-half. For example, the 60-ampere 600-volt switch is in a cabinet 15x8½in., whereas the corresponding switch of usual design has a cabinet 19x15 in. There are no current-carry hinges on the switch, and when the switch is open the live contacts are inclosed in the arc blankets, so that no live parts are exposed. These switches are built in size with four poles up to 100 amperes and 600 volts, for either direct or alternating current.

Small Dust-Tight Compensator

To meet the demand for a small automatic compensator for induction-motor starting, the operation of which will not be affected by the dust prevalent



Method of mounting compensator in dust-tight case

in grain elevators, coal-crushing plants and other similar places, the General Electric Co. announces the device illustrated. It is designed for low voltages and is inclosed in a dustproof boiler-plate case.

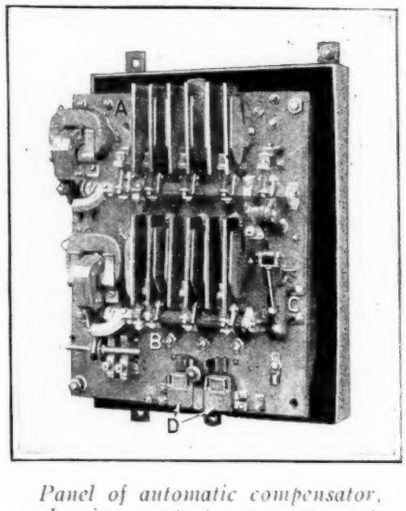
A standard automatic compensator is used in the construction, but the usual conduit box, wall support and top and front covers are omitted. The boiler-plate case in which it is inclosed is made up as a unit with angles on which the compensator may be slid in or out. When the compensator is in position, the angles can be raised to a vertical position, thus allowing the front door to close.

The boiler-plate case is made up of ¼-in. plate. The front cover is held down by 14 wingnuts and clamps against a vellumoid gasket on the case. An extra cable clamp is furnished with the compensator to hold the cables and to take the strain off the terminal board when the compensator is put into and taken out of the case.

Automatic Starter for Squirrel-Cage Induction Motors

An automatic starter of the reduced-voltage type for polyphase squirrel-cage induction motors has been placed on the market by the Cutler-Hammer Manufacturing Co., Milwaukee, Wis. The unit employs an open-delta auto-transformer connection for obtaining lowered starting voltage; it has time-limit acceleration, with inverse-time limit overload protection and low voltage protection. Push-button remote control may be used.

The time interval between the closing of the contactor shown at *A* in the figure, placing the motor on reduced voltage, and of contactor *B*, placing it directly on the line, is governed by an oil dashpot *C*. This time-limit method



Panel of automatic compensator, showing contactor arrangement

of acceleration insures positive starting over any normal range of voltage and load conditions.

The inverse-time limit overload relay, indicated in the figure at *D*, is of the thermal type, and designed to trip at a temperature dangerous to motor insulation.

A single starter covers a considerable range of motor power ratings, the proper heating coil in the thermal overload relay being supplied for any desired rating. A dustproof cover, not shown in the figure, is placed over the unit.

The Cost Reduction Drive in German Industry

By EDWARD J. MEHREN
Vice-President, McGraw-Hill Publishing Company, Inc.

COST reduction is the great slogan today in German industry. Necessity forces Germany to produce as cheaply as possible, for export trade is vital to her economic rehabilitation, and export trade the world over is hampered by high tariff walls and beset with strong competition. Low prices, therefore, are an important factor. They play a part at home, too, for cheaper goods will expand the market.

The cost-reduction idea has taken hold not only in industry, but in the ranks of labor and of the general public. "Rationalization," it is called. The subject is up at every meeting of industrial associations; labor is studying its mechanisms and effects; the general public accepts it as one of the avenues by which not merely German industry, but the whole country economically will be rehabilitated.

WHAT IS "RATIONALIZATION"?

What is meant by "rationalization"? the visitor inquires. It includes standardization, simplification of varieties, waste reduction, scientific management, the replacement of hand labor by machinery, and the consolidation of corporations with a view to securing plant specialization, the closing of uneconomic production units, reduction of overhead, economy in selling, etc.

A word on the consolidations that are a part of the rationalization program. Here, too, as in the scientific and engineering work, there has been government encouragement. Taxes on consolidation transactions effected within a given period (which closes next September) have been reduced. Out of this consolidation era are doubtless coming great corporations that will play a large part in the German industrialism and foreign trade of the near future. Germany, it is commonly said there, has too many small corporations. The present difficult conditions are forcing a lot of them together.

As to the engineering and scientific contributions to "rationalization," a noteworthy feature is the government encouragement that is offered. We, too, have government encouragement of waste reduction work, as exemplified by the activities of the Department of Commerce under Mr. Hoover. But there the encouragement, in addition to being suggestive, takes the form of financial assistance for such studies as would otherwise not be undertaken. Then, when the particular study gets well under way, the government agency endeavors to get the industry to take it over and make available the needed funds.

For the direction of this enterprise the government has established the Reichskuratorium Für Wirtschaftlichkeit, a name that may be translated as National Trusteeship for Economic Studies. Of this organization Dr. Carl F. Von Siemens, head of the Siemens-Schuckert Works, is chairman, and Dr. Hans Hinnenthal, general director.

INVESTIGATION SUPPORTED

The investigations supported cover a broad field, including scientific management, standardization of purchase specifications, bettering of methods in office practice, simplification of varieties, coal economies in dwelling-house heating, use of waste materials, application of machinery to the farm, materials-testing methods, research in use of non-ferrous metals, building-construction methods, improvement in and simplification of dwelling-house design, preparation of study material for apprentices in industry and for students in the higher industrial schools, problems of the works engineer, possible economies in hand-work trades, economy in household work, researches in welding, and heat economies in glass-melting furnaces.

> IT IS the view of industrial leaders that this work is doing a lot for the economic rehabilitation of Germany and that its value will grow with the years. For us in America it should be a spur and challenge to still further effort along the lines of scientific cost reduction, in which we have already made good progress. We must not rest content. Friendly competition in rationalization will be helpful to both nations and their citizens.

STANDARDIZATION

Probably the most important institution engaged in this rationalization enterprise is the Deutscher Normenausschuss, or German Standardization Committee, conducted under the direction of Doctor Hellmich. It is a child of the great German engineering society, the Verein Deutscher Ingenieure, and dates back to war times, in 1917. Its first name was "Standardization Committee of German Industry," but its work has broadened so much that the reference to industry was dropped last year. The Ausschuss itself is a coordinating body largely, yet so extensive is its work that there are fifty people in its office in Berlin. The detailed technical work is done by committees in the various industries, and these have no less than twenty established offices for handling their work. It is estimated that the total expenditure for this standardization work, including travel and office administration runs to 300,000,000 marks annually.

Since the Normenausschuss covers not only standardization of materials, but of forms and sizes as well, it follows that in many fields it covers also what we call reduction of varieties. The procedure is much like that of our American Engineering Standards Committee. The technical work is done by appropriate committees of engineering or industrial associations, and on completion is submitted to the Normenausschuss. If there is no conflict with other standards, the proposed standard is printed in the technical press, with notice that eight weeks are available for submission of criticisms. These criticisms are taken in hand by the committee, and a second draft submitted and published. Again there is opportunity for criticism. After further reworking, the standard goes to the board of directors of the Normenausschuss for approval as a DIN (Deutsche Industrie Normen) standard.

LOOKING AFTER SMALL SAVINGS

As already mentioned, attention is frequently given to subjects that seem of minor import to Americans. Take, for example, standardization of correspondence paper. True, we have "standardized" or "recognized" a limited number of sizes of mill sheets, and have recommended sizes for magazines and catalogs, but the German goes farther, right down to business and private correspondence paper. Not only does he set the size, but he adopts a standard for the arrangement of the letterhead—such space for the firm name and address, such space for the addressee's name and address, such space for the addressee's receiving stamp and notations. Finally, it carries on vigorous propaganda for its adoption.

[Mr. Mehren has just returned from an extended trip through Europe during which he attended the Geneva Economic Conference and later made studies of industrial conditions in several countries.—Editor.]

Full-Voltage Starting of Large A.-C. Motors*

By J. W. Anderson and A. C. Monteith

ON ACCOUNT of greater simplicity and reliability of the control equipment and the ease with which automatic restarting can be obtained, there has been a decided tendency toward full-voltage starting on as many of the auxiliary motors as possible in power stations. As a result of tests there seems to be no question that all squirrel-cage induction-motor windings can be braced to withstand the mechanical effects due to full-voltage starting. A large number of the motors designed for low-voltage starting can be used when full-voltage starting is desired. The large high-speed motors, which have comparatively high starting currents and long coil extensions, require some additional bracing.

In power stations, where the motors are started on the main auxiliary bus feed from the main unit, the starting of the motors on full voltage is usually a matter of mechanical considerations of the load. The drop in voltage at the motor terminals is due to the leakage reactive drop of the transformers and the drop in the cable and bus connecting the motor to the transformers. This is small, as the transformer capacity is much greater than the largest motor to be started.

When the auxiliaries are started from a small auxiliary unit, not only the voltage drop due to the reactance of the generator and the drop in the leads, but also the effect of armature reaction, must be considered. This may appear serious when it is desired to start large motors, but there are several inherent properties in this particular application which make it possible to start such motors, provided good voltage regulation is not essential during the starting period.

If all factors are considered, it is difficult to calculate the voltage drop with any degree of accuracy. When Richmond station was being designed, calculations, using a step-by-step method, were made for several combinations of starting the circulating-water pump motors. When the equipment was installed, tests that were made to determine the voltage drop, indicated better voltage conditions than calculated because pessimistic assumptions were used.

The following is a brief description of the auxiliary generator and the circulating-water pump motors installed in the Richmond station and the tests run:

The auxiliary generator is rated at 3,333 kva., 0.6 power factor, three-phase, 60-cycle, 2,300 volts when running 3,600 r.p.m. No-load field current for 2,300 volts is 68 amperes. The direct-connected self-excited exciter is rated at 33 kw., 250 volts and is a four-pole unit.

The 32-pole motors driving the circulating-water pumps are rated at 500 hp. and 2,200 volts. These motors have a starting torque equal to full-load torque, and a pull-out torque of 2.8 times full-load torque. The slip at full load is 3.3 per cent of synchronous speed. The pump has a calculated torque characteristic which varies approximately as the square of the speed down to 70 r.p.m. Below 50 r.p.m. the torque increases with decrease of speed. The calculated torque with the valve closed is 65 per cent of full-load torque at full speed.

TESTS were made at the Richmond Station of the Philadelphia Electric Company to determine the effects of starting 500-hp., 2,200-volt squirrel-cage motors on circulating-water pumps by connecting them directly across the line. Since the source of power used was a 2,300-volt 3,600-r.p.m. turbine-driven alternator, the test gave an indication of what might be expected if such motors were started from an industrial power station of equal capacity. For this reason these tests are of general interest, as starting of squirrel-cage motors by connecting them directly across the line is becoming quite general practice.

Since the auxiliary generator was required to start three circulating pumps in succession and only two were available for the test, an equivalent load, consisting of two generator ventilating fans driven by 150-hp. squirrel-cage motors and two boiler draft fans driven by 125-hp. wound-rotor motors, was used. The two pumps used were duplicate units on one condenser. In making the tests, the generator and the previously mentioned motors were isolated from the remainder of the station, so that complete tests could be made without affecting the operation of the plant. Two six-element oscillographs with eight-foot films were used in obtaining records of the tests. Besides taking records of the auxiliary generator and exciter voltages and currents, one oscillograph element was connected to a special magneto, giving an indication of the speed of one pump at all times. The tests fall in four distinct groups.

Group I. One circulating-water pump motor was started with no-load excitation on the auxiliary generator. With the pump valve in the open and in the closed positions, tests were also made with the generator under control of the vibrating type of regulator and also with fixed excitation.

Group II. With the equivalent of one motor running and with the voltage adjusted to normal, a second motor was started with the generator under the control of the automatic regulator and also with fixed excitation. The pump valves were open for these and subsequent tests.

Group III. With the equivalent of two motors running and with the voltage adjusted to normal, a third motor was started with the generator under the control of the automatic voltage regulator and also with fixed excitation.

Group IV. With no-load excitation on the generator the two ventilating fans, the two boiler-draft fans and one circulating pump motor were started together, and after an interval a second circulating pump motor was started. These tests were made with the generator under control of the automatic voltage regulator and also with fixed excitation.

Several other miscellaneous tests that were made will be referred to when the results of the tests just cited are reviewed.

The results of the tests under Group I are shown in Fig. 1. With fixed excitation the voltage dropped from 2,350 to 1,850 volts in about one second and the motor accelerated to 67 per cent of synchronous speed. From this point up to full-load speed the impedance of the motor increased rapidly, so that the current decreased. Assuming that the motor impedance is constant and that the reactance and armature reaction becomes effective instantly, a value of 1,400 volts is obtained with no-load excitation on the generator.

Whether the pump valves are open or closed makes little difference on the time to accelerate the motor to full speed. For either condition the current decreased to approximately 110 amperes, gradually increasing to 140 amperes when the valve was open. The motor came up to full speed in both cases in 1.8

*Abstract from a paper, "Auxiliary Power at Richmond Station," presented at the American Institute of Electrical Engineers, summer convention, Detroit, Mich., June 20-24, 1927.

sec. with fixed excitation on the generator.

With the voltage regulator in operation a minimum of 2,060 volts was reached in 0.4 sec. The regulator became effective very quickly, bringing the voltage back to normal in 1.1 sec. In this case it took 1.4 sec. for the motor to come up to speed. The voltage was, therefore, normal before the motor reached full speed. The exciter terminal voltage built up from 110 to 220 volts in 1.1 seconds.

The results of the tests under Group II are shown in Fig. 2. Without the voltage regulator in operation, the voltage dropped to 1,920 volts in one second, and the motor reached full speed in 1.6 sec. With the regulator in operation the voltage dropped to 2,080 volts in 0.4 sec. and the motor was up to full speed in 1.4 seconds.

The results of the tests under Group III are shown in Fig. 3. Without the voltage regulator in operation, the voltage was adjusted to 2,540 volts on the generator with one motor running. The voltage dropped from 2,540 to 2,140 when the second motor was started, recovered to 2,350, and finally reached a minimum of 1,600 when the third motor was started.

A record of the speed of the second motor was taken when the third motor was started. Although the voltage dropped considerably, the speed dropped gradually from 216 to 204 r.p.m. This drop in speed counteracted the voltage drop, so that the current taken by the motor only increased from 140 to 160 amperes. The inertia of the load already on the generator undoubtedly helped the conditions when the third motor was started. The test shows that the current taken by a motor actually decreases for a time. The effect of the inertia may be judged from two tests run. With the valve open and the condenser full of water, a test was made to see how long it would take the motor to stop. In four seconds the motor reversed, and at the end of nine seconds it had reached a maximum speed of 160 r.p.m. in this direction, due to the water flowing out of the condenser. With the valve closed, it took about 40 sec. for the pump to stop.

With the voltage regulator in operation the voltage dropped to 2,080 when the second motor was started. The voltage had been restored to 2,350 volts at the time of starting the third motor and dropped to 2,070 in 0.4 sec., but was restored to normal in 1.7 sec. In this case it took longer to bring the motor up to speed because it was running at 75 r.p.m. in a reverse direction when the voltage was applied. It took 0.6 sec. to stop the motor and a total of two seconds for it to reach full speed.

The results of the tests under Group IV are shown in Fig. 4. Without the voltage regulator in operation the voltage dropped to 1,300 v. in 13 sec. and when the last circulating pump motor was started, the voltage dropped to 900 v. and remained there, as indicated by the full line. The second pump was rotating in a reverse direction, and the voltage was not high enough to produce sufficient torque to stop the pump before the test was discontinued.

Under regulator control the application of the first load caused the voltage to drop to 1,920 volts in 0.6 sec. and it was restored to 2,330 in two seconds.

When the second load was applied, the voltage dropped to 2,000 v. in about one second and was restored to normal in 2.8 sec. Again the pump was running at 70 r.p.m. in a reverse direction, and it took a total of two seconds to start the motor.

The current, when the second load was applied, decreased rapidly to 600 amperes and remained at that value for a time, again falling to 315 amperes. The second drop no doubt indicates where some of the high inertia fans, started with the first load, approached full speed.

In no case did the average speed of the turbine fall more than 3 per cent. Although the currents were comparatively large, the actual load was not excessive and came on the unit gradually.

A test was made to determine the torque necessary to start the motor revolving. This was done by lowering the generator voltage and connecting the motor to the generator by closing the oil circuit breaker. It was found that with 750 volts on the generator, the motor revolved slowly. Considering that the starting torque varies as the square of the applied voltage, this indicates that it took approximately 11 per cent of full-load torque to start the motor revolving. This test was made after the motor had been run for a time.

These tests showed that the actual voltage conditions are much better than calculated, such calculations being based on steady state conditions, assuming an instantaneous decrease of generator flux and constant motor impedance. The tests also show conclusively that an automatic voltage regulator has a decided stabilizing effect.

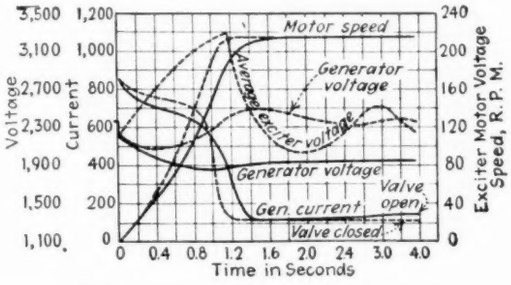


Fig. 1—Test results when starting one motor

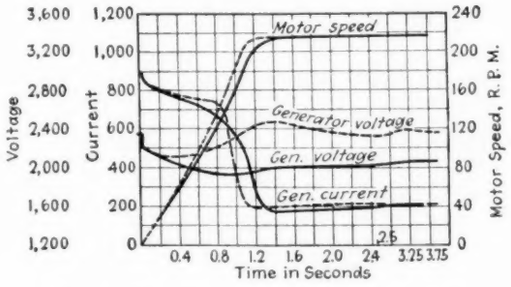


Fig. 2—Test results from starting one motor with a second running

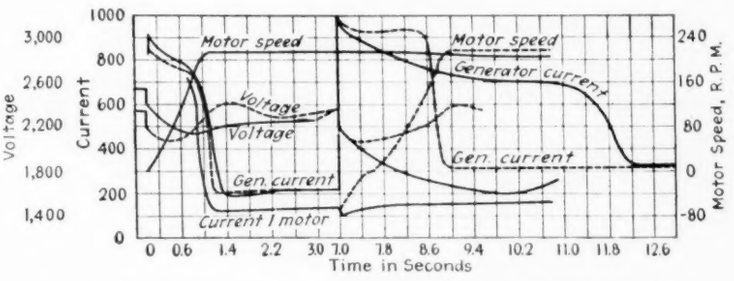


Fig. 3—Test results, without and with a voltage regulator, when one motor was running and two were started

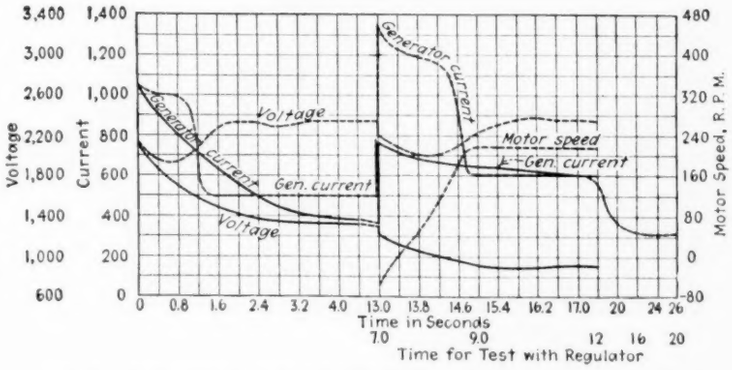


Fig. 4—Test results, without and with a voltage regulator, when two motors were started and then a third

Service Factors Governing Slagging of Boiler-Furnace Refractories

By R. A. Sherman* and E. Taylor†

ONE of the most serious causes of failure of refractories in boiler furnaces fired with coal is the erosion by slag from the coal ash. The factors governing this erosion may be divided into two classes: (1) Service factors, dependent on the type of coal burned and the method of burning; (2) refractory factors, dependent on the type of clay used, and the method of manufacture. The progress report of the A.S.M.E. Special Research Committee on Boiler Furnace Refractories deals with the first class of factors, discussing their significance and presenting values obtained in the field investigation of refractories.

The temperature of the refractory wall and the gradient through the wall make one of the important factors in slag erosion. It is obvious that if the surface of the brick is somewhat softened, the molten ash deposited on it adheres and combines much more readily than if the surface were hard. The temperature gradient through the brick determines the depth of the slag absorption, and it will stop where the temperature is sufficiently low to cause congealing of the slag.

In the furnaces investigated the maximum surface temperatures of the refractories were found to range from 2,500 deg. F. in the walls of underfeed stoker-fired furnaces to between 2,700 and 2,800 deg. in the arch of a furnace burning Illinois coal on a forced-draft chain-grate stoker, and in the side wall of a powdered-coal furnace.

Effect of Reducing Character of Gases

The reducing character of the furnace gases, as determined by the carbon monoxide and hydrogen content, exerts an important influence on the refractory wall erosion. The most generally accepted explanation of the greater slagging in the presence of these gases is the reduction of ferric to ferrous iron, and a consequent formation of ferrous silicates which melt at a lower temperature than ferric silicates.

Of the underfeed-stoker-fired installations investigated, slag adhesion to the walls is the more frequent problem and is due to the class of fuel burned and the more moderate temperatures encountered. However, some deep erosion occurs on the front walls above the tuyeres where the reducing content of the gases is generally greater. It was found that ventilated blocks in the front wall tend to lessen the slag adhesion by cooling the wall and to prevent erosion by maintaining an oxidizing atmosphere.

Chain-Grate Furnaces

In furnaces fired by chain-grate stokers there is usually a zone, two to three feet, from the coal gate, where the gases rising from the fuel bed contain a considerable amount of reducing gases. These are burned when they meet the excess air coming through the rear part of the fuel bed, or by secondary air admitted at the front or through the arch. Where these gases swept the side walls, deep erosion occurred. In one furnace a pipe connected to the air duct was installed through the side wall at the nose of the ignition arch and pointed toward the eroded area. It was found that the reducing gases could be entirely eliminated and the gas temperature reduced from 200 to 300 deg. The furnace was operated for a period of about three weeks after building a new wall in this area, and the erosion, though not entirely eliminated, was reduced considerably.

THE A.S.M.E. Special Research Committee on Boiler-Furnace Refractories under the chairmanship of C. F. Hirshfeld has reported at intervals the progress of its work. The progress report from which this abstract is taken deals with the results of service tests on various types of furnaces burning several kinds of coal.

Powdered Coal Furnace

When burning powdered coal, all the fuel, and consequently all of the ash, is carried in suspension in the gas. The possibility exists that the refractories in a powdered-coal furnace may be bombarded with this greater weight of ash or slag particles, and for this reason it is desirable to keep the furnace gases from impinging on refractory surfaces. Gas analyses and temperature determinations in a pulverized-coal furnace showed that a considerable quantity of CO and H_2 existed at the point where the furnace gases turned upward, and the temperatures reached a maximum of 2,760 deg. at 190 to 240 per cent rating. At this point, where the reducing content of the gases was maximum, it was found, after four weeks of operation, that approximately two inches of erosion had taken place. The coincidence of this eroded area with the area of high temperatures and high reducing gas content served to strengthen the conclusion that reducing gases cause a large part of the erosion in furnace refractories.

Gas Velocities

The gas velocity in the furnace determines the carrying capacity of the gases for solids and the tendency to sweep the molten combination away, thus exposing fresh surface for attack. In chain-grate-stoker furnaces velocities of 40 ft. per sec. were found at the nose of the main arch. On account of the changing condition of the fuel bed the velocities in underfeed-stoker-fired furnaces were very irregular, but the mean velocity over any refractory wall is lower than in the chain-grate furnace. High local velocities do occur because of cracks in the fuel bed and values of 45 ft. per second have been measured. The entrance velocities of the coal and air into the powdered-coal furnace are high, but the mean velocity measured at the side wall of this furnace was about 20 ft. per sec.

The importance of the Fe_2O_3 content of the coal ashes was shown by two photographs. The first shows a heavy accumulation of slag on the walls of an underfeed-stoker-fired furnace in which a coal low in Fe_2O_3 had been burned. The second showed the same furnace after a period of burning with a coal high in Fe_2O_3. Only a thin coating of slag remained on the brick except at the surface of the fuel bed, indicating that considerable erosion had taken place.

Slag Composition

Analyses made of the coal ash and the slag carried in the gases, as well as samples taken from the first row of boiler tubes, showed interesting discrepancies. The slag carried in the furnace gases, as well as the slag deposited on the boiler tubes, contained considerably greater quantities of Fe_2O_3 than shown by the ash analyses. The analysis

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of the ash and refuse indicated a lower composition of Fe_2O_3, and calculations by weighting the composition according to the fraction carried in the gases, and to the ashpit, showed that the increase in Fe_2O_3 in the material in the gases was balanced by its decrease in the ash and refuse.

Slag Quantities

A frequent and entirely logical method of designing a slag test for refractories is that of introducing powdered ash or slag into a flame, to be sprayed on the bricks under test. One of the difficulties of this test has been the lack of information on the quantities of materials that are carried per unit volume of gas under service conditions. Tests have been made which give approximate values for these as follows:

Type of Furnace	Rating, per Cent	Ash Carried by Gases, Grams per 100 Cu.Ft.
Chain-grate-stoker	130	3
	190	6
Underfeed-stoker	133	0.2
	180	1.3
Powdered coal	190	22.0
	240	34 to 63

Arranged in the order of increasing severity of slag erosion, the furnaces studied would be as follows: (1) Underfeed stokers; (2) chain-grate stokers; (3) powdered-coal. Although other reasons for this varying severity of service have been pointed out, it is interesting that the values for the quantities of slag carried in the gases fall in the same order.

Fusion Welding on Boilers and Pressure Vessels*

By F. W. Miller†

PROGRESS in the art of fusion welding has been most rapid, and it is not surprising that some bad work resulted. History shows, however, that this has been true of other rapid developments and much of today's progress is due to the failures of yesterday. Sufficient knowledge of welding has been obtained to determine where it can be safely used, and how its application shall be made to insure that safety. The present developments in welding are based on accurate information and are not empirical, as was the case in earlier days. There is no secret in obtaining successful results by fusion welding, and they can be obtained in either repair work or new construction by anyone who gives proper attention to all the elements entering into job.

Tests Made on New Designs

The organization with which the author is connected designs the structures for fusion welding, using experience and the results of tests as guides, specifies the materials, including the welding wire, and supervises the work of welding. Strain-gage measurements are made all over the structure of each new design, in order to determine the actual stresses that exist under tests and in service. In this way it is known that no part is stressed beyond what it should be, and, if necessary, the design is changed to meet this requirement.

The first welded pressure vessels made were designed for a fiber stress of 7,000 lb. Strain-gage measurements at three times the working pressure made it evident that it was safe to use a higher design stress, and in subsequent designs 8,000 lb. was used. Repeating the strain-gage work showed that 9,000 lb. was a safe working fiber stress, and that figure is used at the present time. All the tanks were tested to three times the working pressure, thus subjecting the material to a 27,000-lb. fiber stress. This is somewhat below the yield point of the material, which is about 35,000 lb. per square inch.

There are now being built tanks 7 ft. in diameter, 35 ft. long, of $\frac{15}{16}$-in. material for 200 lb. working pressure, based on a design fiber stress of 9,000 lb. per sq.in. The seams are all double V-welded with a welding wire whose tensile strength, as deposited in the weld, is about 65,000 lb. per sq.in., and which has an elongation on an average of 15 per cent in 2 inches.

Welders Tested

The welders who do the work have to meet the requirements of a minimum tensile strength in welded test plates made by them in the same material as used for the tank of 45,000 lb. per sq.in. In order to facilitate the tests of welders, a special portable tensile testing machine was designed, having a capacity of 50,000 lb. This machine is about 4 ft. long, weighs 750 lb. and has an accuracy of about 1 per cent of that of a standard machine.

The A.S.M.E. Pressure Vessel Code allows a longitudinal fusion-welded seam with a maximum working fiber stress of 5,600 lb. per sq.in., provided the diameter of the vessel does not exceed 20 in., or the pressure 100 lb. per sq.in. The 9,000-lb. fiber stress used in our design is so much higher than the allowable stress in the A.S.M.E. Pressure Vessel Code that some concern may be felt. It is not, however, as high as may appear, because the 5,600-lb. stress was based on single V-weld tests examined by Prof. R. J. Roark, and the stress reported by him is not the stress per square inch of plate section, but per square inch of weld section, which, when based on the plate section becomes 7,200 lb. The welds from which these tests were taken were inferior, as can be seen by comparing them with good present-day single V-welds made with the same kind of wire, that give about 45,000 lb. per square inch ultimate strength. Double V-welds, when of the same section as the plate, that is, with no reinforcement, give about 52,000 lb. per sq.in. as a maximum ultimate strength. Double V-welds made with high-strength welding rods give, under the same conditions, about 60,000 to 65,000 lb. ultimate strength.

It seems that the figure of 9,000 lb., which is being used at the present time as the basis of design, is not so much in excess of the 5,600-lb. stress as might appear at first. On the basis of 60,000-lb. ultimate strength, 9,000-lb. working fiber stress gives a factor of safety of $6\frac{2}{3}$.

Inspectors Have Difficulty

The author closes his paper by commenting on the difficulty with which the average inspector is confronted when called upon to pass on welded pressure vessels. The instructions issued by his superiors in this regard are usually somewhat vague, and he is forced to rely on his own judgment. Inasmuch as an inspector's efficiency depends upon his knowledge, it is the duty of those who are advocating fusion welding to give the inspector opportunities to learn more about welding.

The State of California, when revising its air pressure tank rules, appointed a subcommittee on welding, which made certain recommendations as to a procedure control to insure dependable workmanship. This report was submitted with the paper to illustrate what may be done, and to indicate the thoughts of some people along this line.

*Presented to the National Board of Boiler and Pressure Vessel Inspectors, Nashville, Tenn.

†Consulting Engineer, Union Carbide & Carbon Research Lab., Inc.

Employer Must Keep Premises Safe

By Leo T. Parker

In the case of Smith vs. American Car & Foundry Co., 288 S. W. 982, the higher Court, in explaining the law relative to the duty of an employer said:

"It is well established in this state that the master's duty to exercise ordinary care to furnish his servant a reasonably safe place in which to work is not restricted to the identical situs of the labor, but extends to the exercise of ordinary care on the part of the master to see that the means of ingress and egress are reasonably safe; and in fact extends to all places about the premises known to the master to be used, or which might by the exercise of ordinary care be so known to be used, by the employees. . . . Furthermore, if the employer knows, or in the exercise of ordinary care should know, that employees are in the habit of using a certain portion of the premises during the noon hour, even for their own convenience, in leaving and returning to the room in which they work, it is his duty to exercise ordinary care to keep such portion of his premises reasonably safe."

NEWS *of the* FIELD

Texas Power Co. Pushes State Water-Power Development

One of the most important contributions to hydro-electric development in Texas is being made this summer by the Texas Power Corp. with the completion of three dams on the Guadalupe River. Spillways for the dams will incorporate bear-trap gates constructed in accordance with designs of Huber and Lutz of Switzerland; this will be the first installation of such collapsible gates in this country, although numerous installations have been made abroad. This type of gate has special advantages when rivers are subject to sudden high floods and when the cost of flowage land is high. Each of the three spillways will consist of three of the bear-trap gates, 85 ft. long and to retain 12½ ft. of water. The gates will be automatic in operation so that as flood occurs they will fold down flat, permitting the spilling of 12½ ft. of water without raising the pond levels at the dams.

Of the three plants the middle one will be manually operated, and an attendant will always be present. The upper and lower ones will be operated as automatic remote-controlled plants from a switchboard at the middle plant. The first plant will have two 2,600-hp. waterwheels driving two 2,250-kva. generators, two governors, remote-control equipment and switchboard; the middle plant will include two 1,900-hp. waterwheels, two 1,750-kva. generators, two governors and switchboard, and the third one will have two 1,650-hp. waterwheels, two 1,550-kva. generators, two governors, remote-control equipment and switchboard.

Load to Suit Pondage

About 8½ miles below the middle plant will be the third one, with an operating head of 25½ ft. It will have two 1,650-hp. waterwheels, two 1,550-kva. generators, two governors, remote-control equipment and switchboard.

Power will be generated at 2,300 volts three-phase 60-cycles. The voltage will be stepped up at each plant to 13,200 volts, and a tie-line operating at this voltage will carry all power to a central point at the middle section, where it will be delivered to the system of the Comal Power Co. Selsyn remote indicators, similar to those in use at the Panama Canal, give the operator at the middle plant the water level and gate position at all plants. Indicating wattmeters, power-factor indicators and ammeters at the middle station give an indication of the load at the two remote plants. Thus the load can be governed to suit flowage or pondage conditions, and the remote plants can be controlled as economically and efficiently as the manually operated station. The engineering of these projects is being done by the Fargo Engineering Co., of Jackson, Mich. All electric equipment is of General Electric manufacture.

Large Power Dam in Idaho Nearing Completion

One of the largest industrial developments in the Pacific Northwest is that nearing completion at Lewiston, Idaho, where a power dam is being built by the Inland Light & Power Co. in connection with the sawmill plant of the Clearwater Timber Co. Completion is expected in the early summer.

The dam will be 1,100 ft. long, with an average height of 35 ft. and a maximum of 55 ft. The average width of the dam at the base is 50 ft. Concrete amounting to 30,000 cu.yd. will be required. Steel in the bridge will amount to 1,000,000 lb. and a like amount will be used in the seven gates, which will be 105 ft. in width and 18½ ft. deep.

The dam will provide a storage pond covering 320 acres and at the outlet of the pond, adjacent to the sawmill, will be the power plant. The dam and log storage facilities will cost more than $3,000,000 and a like sum will be expended by the Clearwater Timber Co.

Electric energy to be developed by means of the dam in the Clearwater River will amount to more than 13,000 hp., and the log storage will hold more than 200,000,000 ft. of logs, which is to be the annual capacity of the sawmill. Contracts with railroad lines to penetrate Idaho pine forests call for delivery of 150,000,000 ft. of logs each year, and additional supplies for the saws will be brought down the Clearwater River.

Excavation work on the Banbury Springs power site filing was begun July 8.

Engineers found that there was water enough to develop about 2,000 hp. of electrical energy, and that there is a fall of 210 feet.

Soot Blower Patent Suit Ends

A suit recently pending by the Diamond Power Specialty Co., manufacturer of Diamond soot blowers, Detroit, Mich., against the Vulcan Soot Cleaner Co., of DuBois, Pa., for infringement of the Diamond company's patents on automatic valved soot blowers, has been discontinued. The Vulcan company has been licensed under these patents.

Acquires Canadian Company

Acquisition of the Rosetown Electric Light & Power Co., Ltd., of Rosetown, Saskatchewan, Canada, was announced recently by the International Utilities Corporation.

Stone & Webster To Build Big Virginia Nitrogen Plant

Stone & Webster has been authorized to design and construct the proposed steam and electric generating station for the Atmospheric Nitrogen Co., subsidiary of the Allied Chemical & Dye Corp. at Hopewell, Va., J. Frank McLaughlin, executive vice-president of the Virginia Electric & Power Co., announced July 9, in the *Richmond News Leader*.

This contract, announced Mr. McLaughlin, is the first step in the building of the atmospheric nitrogen plant of Allied Chemical that has been made public since the company bought the Hopewell property and announced its intention of erecting the plant.

"We are not in a position at this time to state definitely the date when the work will be started, and as to the cost of the steam station, but the work of design and construction will now be pushed as rapidly as possible," read a written statement issued by Mr. McLaughlin.

While current reports, which have not been denied by Allied Chemical, say that the ultimate investment in the Hopewell project will reach $125,000,000, it is understood that the first unit of the plant will not cost more than $15,000,000. Of this sum, it is considered possible that one-third, or approximately $5,000,000 will be spent in erecting the power and steam plant, but no official figures have been made public.

The statement issued by Mr. McLaughlin says in part:

"Our engineers have been working for months past with the Atmospheric Nitrogen Corporation as to the best methods to be pursued in taking care of their power requirements at Hopewell. Their power question is greatly involved with the chemical process to be employed, the equipment to be used, and the source of power is contingent upon tremendous steam requirements.

Penn Central Light Buys Maryland Plant

The Penn Central Light & Power Co. has taken over the operation of the Bedford Electric Light, Heat & Power Co., at Bedford, Md. The Bedford plant has been acquired by the National Electric Power Co., parent company of the Penn Central Light & Power Co.

The lines of the Bedford plant will be tied in with the transmission system of the Penn Central at Claysburg, Pa., a high-tension line now being under construction from that point to Bedford. It is expected to have the line completed by Nov. 1.

Authorizes South Carolina Project—Blocks Tennessean

A license covering an important power development on the Saluda River in South Carolina was authorized at a meeting of the Federal Power Commission held July 8.

This action was taken after the submission of a report by the Chief of Engineers of the Army finding that the project would affect the interests of foreign and domestic commerce and recommending that the Commission take jurisdiction. The license is to be issued to the Lexington Water Power Co., of Columbia, S. C., which expects to install four 32,500-kw. units at Drehers Shoals. Provision is to be made for the installation later of two additional units.

Commission Takes Jurisdiction

Over the protest of the Tennessee Eastern Electric Co. the Federal Power Commission held that power projects on the Holston River and its tributaries would affect navigation on the Tennessee River, and as a consequence took jurisdiction over the projects covered by the applications of the Tennessee company and the Holston River Power Co. The proposed projects conflict.

The Chief of Engineers, in his report, states that the proposed construction would have an adverse effect on interstate commerce under certain methods of operation, but that if operated in accordance with navigation requirements would benefit commerce materially.

Representatives of the Tennessee Eastern Co. contended that the development is too distant from the head of navigation at Chattanooga to have any effect on the river at that point. For that reason they held that state rights alone were necessary.

National Fuels Meeting Is Drawing Up Program

Much interest in the coming National Fuels Meeting, which will be held under the auspices of the Fuels Division of the American Society of Mechanical Engineers at St. Louis, Mo., Oce. 10-13, is already manifest in the rapid progress that has been made in drawing up the program to embrace open discussion all phases of the fuel problem.

More than twenty papers have been promised by eminent authorities on subjects of interest to both users and producers of fuels, and it is planned to devote at least one session to smoke abatement exclusively. It is the hope of the Division to make this meeting one for all engineers, regardless of society affiliations.

Committees are functioning under the following chairmen:

General arrangements, Victor J. Azbe, W. G. Christy, vice-chairman; program, Victor J. Azbe, H. W. Brooks, vice-chairman; publicity, Edwin C. Moody; entertainment, Arthur T. Hunter; hotel, W. Russell Patton; transportation, Norman L. Baker; finance, George B. Evans; reception, Edwards R. Fish; plant inspection, Frederick E. Bausch; printing and signs, Clinton G. Armstrong; information and registration, Steffan Thomas, and relations, William C. Groff.

Coal Storage Urged As Best "Insurance"—Strike Deadlocked

The rate of consumption of bituminous and anthracite coal continues to reflect a moderate decline in industrial activity. During May a total of 37,817,000 tons of bituminous and anthracite was consumed industrially in the United States and Canada. The average daily consumption amounted to 1,219,903 tons. A seasonal readjustment is taking place in practically all branches of business and we expect further curtailment of activity through the summer.

In spite of publicity advising consumers to retain their stocks of coal in storage it would appear that this "insurance" coal, as it may be termed, is being used in larger quantities. The coal survey of the National Association of Purchasing Agents shows a total of 66,510,000 tons on hand as of June 1. This would indicate an average days' supply of 54 days for all industries. Business is beginning to fully appreciate the significance of the non-union bituminous districts. If the necessity arose their production could no doubt be stepped up another million tons a week.

During May, 36,282,000 tons of bituminous were produced—a gain over the previous month of about a half million tons. The anthracite production amounted to 8,193,000 tons, giving a combined total of 44,475,000 tons for the month.

Market Conditions

The time is very near at hand when industrial stocks are usually built up. There is no reasonable justification for burning up coal in storage with market prices what they are today. It can roughly be figured that it costs on an average of 75c. a ton to put coal in and take it out of storage. Loss in heating value of coals in storage over a period of months is negligible. It does represent of course, a capital investment with an interest charge, but it may prove to be the cheapest form of insurance possible to buy. If facilities for storage are available, an ample supply should be kept on hand and current needs supplied from the spot market.

Nothing of interest developed during June in the central competitive district. In the central Pennsylvania section a conference of miners and operators met for further discussion of wage scales but adjourned without agreeing. The operators offered the use of the 1919 wage scale which meant a 20 per cent wage reduction. The miners held out for the Jacksonville scale which the operators would not agree to. As a result the union mines in central Pennsylvania are down from July first. This takes from the market an appreciable amount of high volatile coal available in the East.

Niagara Falls Model Does Its Stuff on Fridays

Regular demonstrations of the model of Niagara Falls are being held by the Niagara Falls Power Co. every Friday afternoon throughout the summer. So many requests for public demonstrations have been received that the management of power company has made this arrangement.

Located in the rear of the Niagara plant the model has been a center of much interest. Government and supplementary surveys, together with aerial photographs, were used in reproducing faithfully the contours of the world-famous cataracts. The model is built exactly to scale and affords a means of conducting experiments in steam control by remedial and compensatory works.

Various methods which have been suggested by American and Canadian government engineers to stop the wearing away of the Horseshoe at the center may be tried out on this model.

Sioux City N.A.S.E. Men Elect Officers

The Sioux City, Iowa, branch of the National Association of Stationary Engineers at its annual meeting elected W. W. Gasser, chief engineer of the Western Iowa Co., president of the society for the year and elected other officers as follows: P. A. Hofland, vice-president; R. A. Heilman, recording secretary; C. H. Amos, corresponding secretary; A. L. Schultz, financial secretary, J. A. Coulsen, treasurer; W. H. Gorman, conductor, and G. H. Barton, doorkeeper.

President Gasser and Frank Fellwick were named delegates to the national convention in Los Angeles Aug. 22-26.

Washington Plans Public Owned Power Service

A publicly owned and operated hydro-electric power project is under way in the state of Washington, this enterprise being planned to first serve communities in central and southeast sections and later to extend to wider territory.

The projected hydro-electric line would thread through the territory now served by three large power companies already in the state—the Puget Sound Power & Light Co., of Seattle; the Washington Water Power Co., of Spokane, and the Pacific Power & Light Co., of Portland.

Slight Fall in G. E. Orders Seen in Recent Output

Orders received by the General Electric Co. for the three months ending June 30 amounted to $78,105,247, compared with $78,972,062 for the second quarter of 1926, a decrease of one per cent, President Girard Swope has announced.

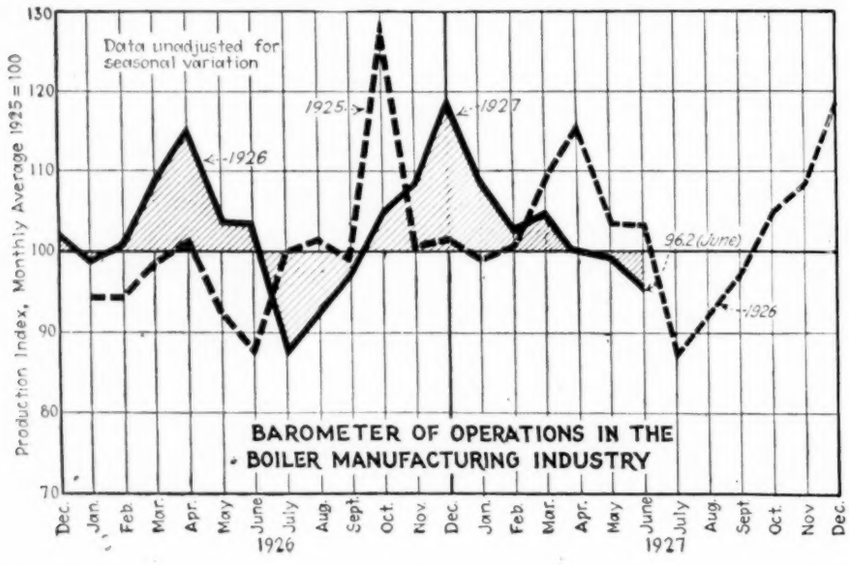
For the six months ended June 30, orders totaled $155,655,828.

Boiler Output for Half-Year 2.3 Per Cent Under 1926

The downward trend in boiler production which started in January was continued through June. The June production of these plants was 3.4 per cent under May and 6.8 per cent under June of last year. The June volume of production was about 11.7 per cent under that reported for January. Such a gradual reduction in volume of boiler manufacture is to be expected at this season of the year, although the spring of last year seems to have witnessed a materially increased activity during March and April. It is probable that a further reduction will take place during July, after which the industry should respond to the favorable influences which normally operate during the fall months. The volume of boiler production during the first half of the year was about 2.3 per cent under that of the same period last year. Such is the status of productive operations in the boiler manufacturing plants of the nation as indicated by reports received by *Power* on the monthly consumption of electrical energy.

The present trend in general manufacturing seems to be materially different from that reported by the boiler manufacturing industry. Based upon the reports of some 2,500 manufacturing plants consuming approximately 14-billion kilowatt-hours of electrical energy per annum, the volume of general production during June was about 8.4 per cent over June of last year. The usual seasonal drop in production in industry as a whole, which is normally expected at the later part of the year, seems to have been greatly minimized in comparison with past years, some industries, such as the textile and lumber industries which during the past two or three years have experienced large reductions in productive activities from March to July, appear to have continued to operate close to and even above the March operations. Other industries, such as the metal industries, while recording a seasonal curtailment in production, have not recorded a proportionate drop in activities which the history of the last two years would seem to warrant.

The mere fact that during the first half of the year the boiler manufacturing plants have recorded a volume of production under that of the same period of 1926 is within itself a basis for believing that a period of comparatively high production will be witnessed during the coming Fall months. Construction contracts let during the last six months were only slightly below the value of such contracts let during the same period of 1926, and the operations of the electric light and power industry during the first half of the year indicate that not only large power-house extensions must be undertaken to meet the future potential load, but that existing power plants are being run at near capacity calling for even greater replacements than was to be expected.



Obituary

Merrill Van G. Smith, dean of engineering of the University of Delaware, and professor of mechanical engineering, died on April 24, in Philadelphia. He was born in 1871 and attended Stevens Institute at Hoboken, N. J., from which he was graduated with the degree of M.E., class of 1896.

After graduation, Dean Smith joined the editorial staff of the *Railway Age Gazette*. His next venture was in 1898 in the field of teaching as instructor in mechanical engineering at the University of Pennsylvania. After a year at this institution Dean Smith became professor of mechanical engineering at the Clarkson School of Technology. Going to the University of Delaware, from Clarkson, in September, 1904, he served the University as professor of mechanical engineering and for the last six years as dean. He has been a contributor to mechanical publications in matters relating to navigation.

He was a member of the Society for the Promotion of Engineering Education, and the Engineers' Club of Philadelphia. He became a member of the American Society of Mechanical Engineering in 1915.

Capt. Henry M. Seeley, who for the past few years has been sitting with the Boiler Code Committee of the American Society of Mechanical Engineers as representative of the Supervising Inspector General of the U. S. Steamboat Inspection Service, died May 28. Captain Seeley was born in Nova Scotia, Dec. 2, 1857. Much of his boyhood and early manhood was spent at sea, starting in the forecastle and ending on the quarterdeck both of sailing and of steam vessels. On March 2, 1895, he was appointed associate inspector of Hulls at New York. On Aug. 10, 1901, he was transferred to Boston, and promoted to the position of local inspector of Hulls. On Oct. 24, 1904, he was transferred to New York as local inspector of Hulls; and on Aug. 3, 1911 he was appointed supervising inspector of the Second District at New York, which position he held at the time of his death. Captain Seeley's interest in and valuable co-operation in the work of the Boiler Code Committee was appreciated to such an extent that resolutions of esteem and sympathy were passed at a recent meeting.

Personal Mention

Auguste C. E. Rateau, of Paris, France, honorary member of the A.S.M.E. recently paid a short visit to New York in connection with the maiden round trip of the large new liner, the *Ile de France*. He called at the editorial offices of *Power* to pay his respects to Fred R. Low, editor.

Peter Dias, formerly lieutenant in the United States Navy as senior engineer officer on naval transports during the World War, and recently chief engineer of the Continental Paper Co., has been appointed plant engineer of the New Essex County Hall of Records power plant, Newark, N. J. Mr. Dias is a member of the American Society of Mechanical Engineers.

Robert Cramer, formerly chief engineer of the Kingsford Foundry & Machine Works, Oswego, N. Y., and consulting engineer specializing in power plant design, water works construction and sewerage disposal and research in Milwaukee, Wis., recently assumed the duties of the newly created office of chief engineer of the Sewerage Commission of that city. Mr. Cramer was appointed a member of the Commission in June 1923.

Business Notes

The Ironton Fire Brick Co., Ironton, Ohio, has announced the appointment of F. W. Lucke Brick Co., 133 W. Wash-

ington St., Chicago, as representatives in that city.

The Quigley Furnace Specialties Co., Inc., has announced the appointment of J. W. Marshall as advertising manager.

The Pennsylvania Pump & Compressor Co., air compressors, vacuum pumps, centrifugal pumps and air lift pumps, Easton, Pa., has appointed P. I. Perkins Co., 110 High St., Boston, as representative in that territory.

G. W. Craighead, has recently been appointed district representative for Foote Bros. Gear & Machine Co. and will cover the eastern half of the State of Michigan with headquarters at 4-230 General Motors Bldg., Detroit, Mich.

The Dayton-Dowd Co., manufacturer of centrifugal pumps, Quincy, Ill., has announced that E. G. Dewald, 206 West Temple St., Salt Lake City, now represents the company in the sale of Dayton-Dowd centrifugal pumps in the Salt Lake district.

The Foote Bros. Gear & Machine Co. announce that they have recently completed arrangements for the handling of IXL speed reducers and gear products in the northern half of the State of Oklahoma by the Circle Corp., P. O. Box 1224, Tulsa, Okla.

The Pioneer Rubber Mills, manufacturers of mechanical rubber goods, 345-353 Sacramento St., San Francisco, Calif., have appointed the McKinnon Iron Works as distributors for SKOO-KUM piston rod packing for Ashtabula, Ohio and near-by territory.

The Bridgeport Brass Co. announces the appointment of William S. Kriebel, Jr., of Philadelphia, as salesman of Bridgeport Brass products in the Philadelphia territory. He will make his headquarters at the Bridgeport Brass Co.'s Philadelphia office, located at Bankers Trust Building.

A. H. Tischer, formerly of the development engineering department of Foote Bros. Gear & Machine Company, has been transferred to the sales organization and is now covering territory in Chicago, South of 39th Street. He is also covering suburbs and the steel district in South Chicago and Northern Indiana.

Ingersoll-Rand Co., 11 Broadway, New York City, has opened a branch office at 236 High St., Newark, N. J., for the service of northern New Jersey and adjacent counties of New York State. F. K. Armstrong, formerly connected with the company's New York Sales Branch, has been appointed manager.

Coming Conventions

American Institute of Electrical Engineers. F. L. Hutchinson, secretary, 33 West 39th St., New York City. Pacific Coast convention at Del Monte, Calif., Sept. 13-16.

American Society of Mechanical Engineers. Calvin W. Rice, secretary, 33 West 39th St., New York City. Seattle, Wash. Section, Aug. 29-31.

Canadian Steel and Power Show and technical sessions will be held at the University of Toronto Arena, Toronto, Ont., Aug. 31, Sept. 1 and 2; Campbell Bradshaw, general chairman of exposition committees, 153 University Ave., Toronto, Ont.

National Association of Practical Refrigerating Engineers. Eighteenth annual convention and educational exhibition in Civic Convention Hall and headquarters Hotel Whitcomb, San Francisco, Calif., Nov. 29 to Dec. 2. H. Fox, 5707 W. Lake St., Chicago, Ill.

National Association of Stationary Engineers—Annual convention at Ambassador Hotel, Los Angeles, Calif., Aug. 22-27, in connection with the Pacific Coast Power and Mechanical Exhibit. Wisconsin convention at Racine, July 19-22, secretary R. L. Scott, 410 Congress St., Eau Claire, Wis.

National Fuels Meeting, under the auspices of the Fuels Division of the American Society of Mechanical Engineers, will be held Oct. 10-13 at St. Louis, Mo.

Universal Craftsmen Council of Engineers. Thomas H. Jones, secretary, 33 Linden Ave., Cherrydale, Va. Annual convention at Buffalo, N. Y., Aug. 2-6.

Trade Catalogs

The Worthington Pump & Machinery Corp. takes the reader of Bulletin W-821 through the meter factory at Harrison, N. J.

Centrifugal Pumps for General Service.—The Worthington Pump & Machinery Corp., 115 Broadway, New York City, has issued Bulletin No. W613 on Worthington high-efficiency centrifugal pumps. The bulletin describes the new pumps in detail, and tells how 10,000 pump inquiries were analyzed to determine the heads and capacities most commonly specified by pump users.

Climax Engines—The Climax Engineering Co., Clinton, Iowa, has issued a series of booklets, averaging forty pages each, containing parts price lists and operation instructions for Models R6U, R4U, and TU engines and power units. Each of these books contains detailed lists of parts with illustrations of each part, complete instructions for the care, operation and adjustment of each engine as well as other pertinent information which might be needed by the user of Climax engines. Copies of these parts books will be sent on request to users of Climax engines.

Chains and Transmission. — The Chain Belt Co., Milwaukee, Wis. A new catalog on Rex chains and transmission equipment has just come off the press. This new book contains all of the new list prices effective July 1. It portrays, in addition to the lines shown in the catalog 210 which it supplements, new types of chains recently developed. In compiling this book, an effort was made to include a complete tabulation of all essential data for ordering as well as a detailed description of the type of chain and its possible uses.

Air Compressors—The Pennsylvania Pump & Compressor Co., Easton, Pa., has issued a new bulletin No. 133, describing model "121" Pennsy-Portable air compressors. The leaflet is illustrated, and is concluded with specifications.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run except Pittsburgh gas slack:

Bituminous Net Tons	Market Quoting	July 5, 1927
Pool 1	New York	$2.50@$2.75
Smokeless	Boston	1.61
Clearfield	Boston	1.65@ 1.90
Somerset	Boston	1.75@ 2.00
Kanawha	Columbus	1.35@ 1.50
Hocking	Columbus	1.75@ 1.90
Pittsburgh	Pittsburgh	1.90@ 2.15
Pittsburgh gas slack	Pittsburgh	1.40@ 1.60
Franklin, Ill	Chicago	
Central, Ill	Chicago	
Ind. 4th Vein	Chicago	
West Ky	Louisville	1.35@ 1.60
S. E. Ky	Louisville	1.40@ 1.60
Big Seam	Birmingham	1.50@ 1.90
Anthracite Gross Tons		
Buckwheat No. 1	New York	2.40@ 3.00
Buckwheat No. 1	Philadelphia	2.50@ 3.00
Birdseye	New York	1.25@ 1.60

FUEL OIL

New York—July 14, light oil, tank-car lots; 28@34 deg. Baumé, 5½c. per gal.; 36@40 deg., 5½c. per gal. f.o.b. Bayonne, N. J.

St. Louis—July 6, tank-car lots, f.o.b. St. Louis; 24@26 deg., $1.65 per bbl.; 26@28 deg., $1.70 per bbl.; 28@30 deg., $1.75 per bbl.; 30@32 deg., $1.80 per bbl.; 32@36 deg., gas oil, 4.6c. per gal.; 38@40 deg., 5.3c. per gal.

Pittsburgh—July 5, f.o.b. local refinery; 30@34 deg., fuel oil, 4¾c. per gal.; 36@40 deg., fuel oil, 5c. per gal.

Philadelphia—July 7, 27@30 deg., $2.20½@$2.26½ per bbl.; 13@19 deg., $1.68@$1.74 per bbl.

Cincinnati—July 5, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 6½c. per gal.; 26@30 deg., 6⅝c. per gal.; 30@32 deg., 7c. per gal.

Chicago—June 25, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 92c. per bbl.; 24@26 deg., 97½c. per bbl.; 26@30 deg., $1.00; 30@32 deg., $1.10.

Boston—July 6, tank-car lots, f.o.b. 12@14 deg. Baumé, 4¼c. per gal.; 28@32 deg., 5.85c. per gal.

Dallas—July 9, f.o.b. local refinery, 26@30 deg., $1.40 per bbl.

New Plant Construction

Ark., Clarksville — Bd. Comrs. Electric Light Impvt. District 2 took bids July 15, for construction and equipment 750 kw. municipal power plant. W. N. Gladstone, Fayetteville, is engineer.

Ark., Magnolia—Magnolia Cotton Mill Co., T. S. Grayson, Pres., awarded contract for the construction of textile mill, including boiler house, etc., to T. S. Byrne Eng. & Contg. Co., First Natl Bank Bldg., Fort Worth, Tex. Estimated cost $121,000.

Calif., Los Angeles—Los Angeles County Medical Bldg. Corp., will soon award contract for the construction of a 13 story office building including steam heating system, elevators, etc. at Wilshire Blvd. and Westlake Ave. Estimated cost $750,000. J. & D. B. Parkinson, 420 Title Insurance Bldg., are architects.

Calif., Los Angeles—J. Hawley, Kipling Hotel, plans the construction of a 12 story apartment building at 7th and Bernado Sts. Estimated cost $500,000.

Calif., Monterey Park—City taking bids installing air chambers on 9,000 lin.ft. booster pump line. O. A. Gierlich, 1st Natl. Bank Bldg., Monrovia, is engineer.

Calif., Orange Grove—Foothill Irrigation Dist., plans election to vote $2,500,000 bonds for irrigation of 50,000 acres, including pumping equipment, etc. M. W. Enderlein, Brix Bldg., Fresno, is engineer.

Ill., Decatur—Antlers, Inc., A. Milner, Pres., 304 West Wood St., will build 14 story hotel, including elevators, boilers, etc., on North Church St. Estimated cost $650,000. Work will be done by separate contracts.

Ill., Macomb—Western Illinois State Teachers College, awarded contract for the construction of gymnasium and power house, to J. C. Hunzinger & Co., Security Bldg., Davenport, Ia., $150,000.

Ill., Waukegan—Syndicate c/o A. Alschuler, Archt., 29 East Jackson Blvd, Chicago, awarded contract for the construction of 8 story bank and office building, at Washington and Genesee Sts., here to J. J. Redding & Co., 10 North Clark St., Chicago. Estimated cost $500,000.

Ia., Iowa City—State Bd. Educ., W. H. Gemmill, Secy., Des Moines, had plans prepared for the construction of addition to heating plant. Estimated cost $160,000. Proudfoot, Bird & Souers, 810 Hubbell Bldg., Des Moines, are architects.

Md., Baltimore—Baltimore Trust Co., Light and Baltimore Sts., having plans prepared for the construction of 20 story bank and office building, Light and Baltimore Sts. Estimated cost $2,000,000. Smith & May, Calvert Bldg. and Taylor & Fisher, Union Trust Bldg., are architects.

Md., Baltimore—C. Hoffberger Co., 538 East Monument St., plans constructing group of buildings, including 6 story cold storage warehouse, with complete equipment, at Monument, Forest and Clark Sts. Estimated cost $500,000.

Md., Baltimore—Lord Baltimore Hotel, H. Busick, Pres., Hanover and Baltimore Sts., awarded contract for the construction of 22 story hotel at Baltimore and Hanover Sts., to Consolidated Eng Co., 20 East Franklin St. $6,000,000.

Mich., Flint—Patterson Building Co., Harrison and 3rd Sts., having plans prepared for the construction of a 14 story hotel, on Harrison St. $900,000. W. H. Maurer, Cleveland, architect.

Mich., Pontiac—Yellow Truck & Coach Mfg. Co., General Motors Bldg., Detroit, plans the construction of group of factory buildings, including 100x100 ft. power house. Total estimated cost $8,000,000. Private plans.

N. J., Bridgeton—C. P. Cory, City Clerk, City Hall, takes bids until August 2, constructing 2 sewage pumping stations, etc. Remington & Vosbury, 509 Cooper St., Camden, are engineers.

Mo., St. Louis—Eighteenth and Pine Trust, c/o J. S. Lionberger, 312 North 8th St., awarded contract for the construction of 14 story and basement, hotel, at 18th and Pine Sts., to R. Collins, 51st St. and Worral Rd., Kansas City. Estimated cost $900,000.

N. J., East Orange—Thirty Nine Prospect Corp., c/o H. Van Duyne, Inc., 2 Washington St., awarded contract for the construction of 10 story apartment, here, 35-42 Prospect St., to Deakman-Wells Co., 921 Bergen Ave., Jersey City. Estimated cost $1,500,000.

N. Y., Albany—Bd. Supervs. plans the construction of group of buildings, including power house, hospital, nurses' home, penitentiary, etc., near here. Estimated cost $2,500,000.

N. Y., New York—A. Bing, 581 5th Ave., awarded contract for the construction of 22 story office and loft building, at 20 East 48th St., to Gresham Constr. Co., 587 5th Ave. Estimated cost $500,000.

N. Y., New York—New York Central R. R. Co., 466 Lexington Ave., awarded contract for the construction of 35 story office building on Park Ave., between 46th and 47th Sts., to J. Stewart & Co., Inc., 17 East 42nd St., Archts. Estimate $16,000,000.

O., Akron—St. Thomas Hospital awarded contract for the construction of 6 story hospital building, to Carmichael Constr. Co., Central Land & Trust Bldg., Akron. Estimated cost $500,000.

O., Cleveland—Association Building Co., c/o G. W. Crite, East 93rd St. and Euclid Ave., awarded contract for the construction 5 story hospital addition and 2 story power house, at East 93rd St. and Euclid Ave., to Crowell & Little Constr. Co., Hanna Bldg. Estimated cost $225,000.

O., Cleveland—Charity Hospital c/o J. E. Crew, East 22nd St. and Central Ave., awarded contract for the construction of 2, 3 and 5 story hospital and nurses' home, East 22nd and Centnral Ave., to Lundoff-Bicknell Co., B. F. Keith Bldg. Estimated cost $1,200,000.

O., Cleveland—St. Charles Roman Catholic Church, N. F. Monaghan, pastor, Wilbur Ave. and Ridge Rd., had plant prepared for school and power house on Ridge Rd. Estimated cost $150,000. W. Koehl, 1720 Euclid Ave., is architect.

O., Columbus—Bd. Trustees State University, C. L. Steeb, Secy., having plans prepared for the construction of addition to power house on Ohio State University Campus. Estimated cost $125,000. J. N. Bradford, Ohio State University, is architect.

Okla., Woodward—Empire Gas & Fuel Co., Bartlesville, having plans prepared for the construction of gas compressor station, including four 180 hp. compressor units, etc. Estimated cost $45,000. Private plans.

Ore., Portland—Rose Holding Co., c/o E. B. Seabrook, Yeon Bldg., having plans prepared by L. L. Dougan and E. Miller, Kramer Bldg., for the construction of an apartment hotel, at West Park and Jefferson Sts. Estimated cost $1,000,000.

Pa., Lansdale—Borough Council, N. C. B. Kriebel, Secy., takes bids until July 28, constructing pump house, electrically driven pumping equipment, etc., for sewage plant. Albright & Mebus, 1502 Locust St., Philadelphia, are engineers.

Pa., Warren — Warren State Hospital takes bids in about 2 months for the construction of 2 story hospital building, here. Estimated cost $500,000. E. Fisher Wood & Co., Hardy and Haynes Bldg., Pittsburgh, are architects.

S. C., Charleston—Bureau Yards & Docks, Navy Dept., Wash., D. C. plans rewinding dry dock pump motors at Navy Yard, here. Spec. 5443.

S. D., Rapid City—Hotel Alex Johnson, c/o Oldefest & Williams, Archts., 605 North Michigan Ave., having plans prepared for the construction of 10 story, hotel, including 2 elevators, etc. here. Estimated cost $750,000.

Va., Hopewell — Atmospheric Nitrogen Co., subsidiary Allied Chemical & Dye Corp., 61 Bway., New York City, awarded contract for the construction of steam electric generating plant, here, to Stone & Webster, Inc., Boston, Mass. Estimated cost to exceed $5,000,000.

Tex., Waco — Hilton Hotel Co., C. N. Hilton, c/o Hilton Hotel, Dallas, takes bids until July 26, for the construction of 14 story hotel, here. Estimated cost $700,000. Lang & Mitchell, 300 Amer. Bank Bldg., Dallas, are architects.

Tenn., Knoxville—City having plans prepared for the construction of refrigeration plant on Market St. Estimated cost $30,000.

Tex., Donna—C. W. Napier, Travis Bldg., San Antonio, having plans prepared for the construction of a 1 story dry and wet cold storage plant here, and one at San Benito. Estimated cost $40,000 each. Private plans.

Tex., Weslaco—Rio Grande Products Corp., c/o W. R. Burns, Harlingen, having preliminary plans prepared for the construction of ice and cold storage plants in lower Rio Grande Valley. Estimated cost $40,000.

Ont., Toronto—Dominion Rubber Co., Ltd., 1 Front St., East, having plans prepared 15 story office and show rooms, including steam heating system, electric elevators, etc., at Front and Longe Sts., here. Estimated cost $1,000,000. R. B. McGiffen, 96 Bloor St., West, is architect.

Ont., Toronto—J. T. Ransone & Co., Metropolitan Bldg., will build 3 story apartment, including steam heating and refrigeration system, at Yonge St. and Farnham Ave. Estimated cost $500,000. Work will be done by day labor.

Equipment Wanted

Boilers, etc.—Chairman Railway Board, Wellington, New Zealand, takes bids until November 24, boilers, electric tilting furnace, etc.

Drilling Equipment — Earlsboro Oil Co., 15½ Main St., J. W. Drake, Pres., Shawnee, Okla., plans drilling project, including power unit, steel derricks, and other drilling equipment. Estimated cost $60,000. Private plans.

Engine, Generator, etc.—Treas. Dept., at office Supervising Architect, Wash., D. C., takes bids until July 26, furnishing and installing new engine generator, etc., at U. S. Post Office and Court House, here. J. A. Wetmore is acting supervising architect.

Pumps, etc. — City Council, Chetopa Kans., takes bids until July 14, pumps and engines for waterworks and light system extensions. Estimated cost $75,000. A. C. Moore, Joplin Natl. Bank Bldg., Joplin, is engineer.

Pumping Equipment—City Buhler, Kan., taking bids on pumping equipment for complete waterworks and distribution system. Estimated cost $30,000. F. E. Devlin, 614 Bitting Bldg., Wichita, is engineer.

Pumping Equipment—Cameron County Water Control & Impvt. Dist., 6, Tex., c/o D. Gilley, Dir., plans election July 23, to vote $16,000 bonds for pumping equipment, including electric motor, for 2nd lift plant $5,300, and engine and pump for River plant, $10,000.

Power Plant Equipment—B. C. Dunlap, Throckmorton, Tex., plans installing complete equipment for electric light and power plant, including lighting system and power unit. Estimated cost $60,000. Private plans.

Pumping Equipment—Los Angeles Co., Los Angeles, Calif. taking bids pumping equipment, pump house and derrick, at Los Angeles County Farm, near Downey. Estimated cost $5,000.

Turbo Generator, etc.—Laclede Power & Light Co., 11th and Olive Sts., St. Louis, Mo., soon takes bids for 12,500 kw. turbo generator, boilers, coal and water handling equipment, etc., for addition to power plant. Estimated cost $498,000. Private plans.